THE

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CONTENTS:

	PAGE
The Ethics of Electrical Engineering	1
Electric Automobiles	3
Electric Traction and Transmission in the New Century	6
Telephone Transmission (*illustrated*)	9
Parallel Running for Central Stations	10
Fault Finding on Tramway Systems (*illustrated*)	12
Correspondence:—	
Tests of Electric Hoists	12
Underground Railway Systems	13
Blast Furnace Gas Power Installation	14
Nernst Electric Lamp	14
A Two-Phase Problem (*illustrated*)	14
Information Wanted	14
The Vicarino System of Train Lighting	15
Business Notes	15
Coal and Ash Handling, and Storage Plants for Electric Light and Power Stations (*illustrated*)	20
Beckenham Electricity Works (*illustrated*)	22
Supply Station Accounts	30
City Notes	31
Traffic Receipts	32
Stocks and Shares	32
Share List of Electrical Companies	33
Market Quotations	34
Metal Market.—Fluctuations in December, 1900	35
Institution of Electrical Engineers:—	
On Rapid Variations in the Current through the Direct Current Arc (*illustrated*) (*concluded*)	35
Institution of Electrical Engineers (Dublin Section):—	
On Electric Currents of High Tension and Great Frequency	37
Systems of Current Distribution on Tramways (*continued*)	38
The American Law Relating to Electricity	39
The Use of Searchlights in Naval Warfare	40
One Method of Dealing with the High Voltage Arc Lamp Trouble (*illustrated*)	41
Current Specifications.—XLIII.	42
New Patents	43
Abstracts of Published Specifications	44

THE

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THE ETHICS OF ELECTRICAL ENGINEERING.

IN a recent issue of the REVIEW a correspondent, signing himself "Consultant," suggested that we should address ourselves to the question whether the interests of the electrical profession were best served by entrusting the design of new installations to gentlemen confining themselves entirely to consulting work, known usually as "consulting engineers," or to those holding posts as managing engineers to electrical undertakings belonging to local authorities, usually known as "municipal electrical engineers."

In order to enable us to consider the very interesting point raised by our correspondent, we will assume that the principals in the transaction are a local authority about to inaugurate an electric supply system, the local authority being *inter alia* anxious as buyers to deal in the best market and to secure the best value for their money.

Under these circumstances we have to ask whether the desired result can be best secured by employing a consulting engineer solely devoting himself to this class of work, or to one who is in receipt of a salary from another local authority for duties involving daily a full day's work, and who therefore is able to deal with the matter in his leisure time only.

In order to permit us to come to a decision, we have to consider the matter from three or four points of view. Firstly, What work is involved in the duties to be performed? Secondly, To what extent is the ordinary consulting engineer capable of fulfilling the duties? Thirdly, What are the superior advantages accruing from engaging the services of an engineer occupied in the daily supervision of running plant? And, fourthly, How far his daily work would interfere with his fulfilment of the duties involved?

Taking these points in order, we presume we are right in supposing that the local authority would desire the gentlemen to whom it has entrusted its interests to make a careful survey of the town in order to study the local conditions, and, during the inception of the scheme, to attend its meetings in order to settle the details of the scheme. The authority would also desire him to act, as it were, as its buyer, and, with this in view, to draw specifications of its requirements, and to issue the necessary plans in order to get in public tenders. It would desire him to do all that was necessary under the provisional order, such as the obtaining from the Board of Trade the sanction to the system, and the preparation of the statutory maps of mains; it would desire him to be its intermediary with the Local Government Board, to which the Legislature has relegated the sanction of loans raised under the Public Health Act. He would be required to supply the Local Government Board with the necessary plans, and when the Local Government Board inquiry was fixed, to attend the same in order to expound the scheme before the inspector. When the tenders came in he would have to make a careful synopsis of them, and would no doubt be expected to attend the meetings of the Electric Lighting Committee when his report was under discussion. After the contracts were allotted it would be his duty to settle all the technical details, and to be responsible

for the accuracy of the contract drawings. If the general conditions attached to the specification were anything like those which we have from time to time criticised in these columns, they would doubtless provide that the representative of the purchasers should inspect the progress of the work on the contractor's premises; he would have to see that the foundations for the plant were properly set out in the central station, and subsequently to supervise the laying down of the plant there; he would have to enact the duties of an accountant in the matter of keeping the records of the accounts with the contractors, measuring up the work from time to time, and issuing certificates of payment; and when the work was completed it would be his onerous duty to make the complete tests of plant and to certify or otherwise as to the conformity of the same with the specification.

It will be known to our readers that in addition to these duties, the engineer appointed frequently acts as arbitrator in case of dispute, though this is a duty which, in our opinion, should properly belong to an independent person.

On the whole, it will be seen that the local authority would properly expect from the intermediary chosen by it a very heavy drain upon his time.

It is now for us to consider to what extent a consulting engineer, acting solely in that capacity, can fulfil the above duties. Obviously he could not properly fulfil those duties if there were truth in what was recently written by a contemporary—"in the early days of electric lighting the consulting engineer got mixed up with the contractor sometimes, and has not quite extricated himself even yet." No person could properly act as the trusted adviser of the purchaser who had interests in a manufacturing concern; we resent, on behalf of our leading consulting engineers, the aspersions, in this respect, cast upon them by our contemporary, and we may proceed on the assumption that whether a consulting engineer or a municipal electrical engineer be appointed, either will be entirely without contracting interests.

We return, therefore, to the question to what extent a consulting engineer, solely devoting himself to that class of work, can fulfil the duties properly expected by the local authority inaugurating an electric undertaking. The list of duties is a long one, and if the consulting engineer has more than one job in hand he will not be able to see everything done with his own eye, but will act as the supervisor of others. There are, however, certain duties which he will not be able to delegate to others, such, for instance, as the conferences with the Electric Lighting Committee, the actual preparation of specifications and the attendances at the Board of Trade and Local Government Board, as well as the supervision of the final tests on site. If he is a good organiser and has a sound engineering staff, the remainder of the duties should, under his supervision, be efficiently performed, and one job succeeding another on somewhat similar lines, the varied heads of the work, such as the inspection of plant at makers' works, should grow into a system.

An objection is sometimes raised to the appointment of a consulting engineer, that as he is not actually engaged in running plant he is liable to specify fads which are of little value to the working engineer. On the supposition, however, that the consulting engineer to be appointed is in active practice, it is obvious that he has good opportunities of seeing his own work in operation, and, from the multiplicity of his jobs, he ought to gain a very extended experience of plant in actual operation.

From the mere £ s. d. point of view, a purchaser is certainly better off in entrusting the buying of his plant to one who is constantly coming into the market than to one who has only an occasional job to give out.

So much for the consulting engineer's side of the question. Let us now turn to that of the municipal electrical engineer.

As in the case of the consulting engineer, we may in the first case profitably consider what are the duties to be performed by a municipal electrical engineer in charge of a municipal undertaking.

In that position he is made responsible by the local authority for the proper conduct of works in which a capital of, say, £100,000 or £200,000 is invested. Upon the care with which he exercises his daily and nightly duties will depend the continuity and efficiency of the service and the economical working of the plant, while the assiduity with which he carries out his duties will have a marked effect upon the financial result at the end of each 12 months.

These duties are extremely onerous, for in the carrying on of a 24 hours' service he is liable at all hours of the day and night to be appealed to for guidance by his subordinates; in the conduct of an industrial undertaking he will have to personally grapple with labour troubles, and upon his tact and care it will depend whether the capital expended shows a satisfactory return to the local authority or not.

These being his duties, we are able to consider our last point, namely, to what extent he is able to add to those duties the post of consulting engineer to other local authorities.

The municipal electrical engineers of this country are, as a class, men who are imbued with a sense of the seriousness of their position, and who endeavour to fulfil their duties in the thorough manner which their employers have a right to expect from them. For instance, to turn the tables, we fancy such a one would give a very emphatic reply to a query as to whether his duties could be satisfactorily performed by a consulting engineer out of Great George Street, whose time was already greatly occupied in fulfilling the duties set out in the earlier portion of this article.

Surely the converse holds true, and enables us to give the following reply to our correspondent:—

If a municipal electrical engineer is thoroughly performing the duties which devolve upon him in the conduct of the electricity supply undertaking of his town, he has absolutely no time at his disposal to carry out consulting work for other municipalities. If he does so, he can only do it at the curtailing of the energy and work which the local authority employing him has a right to expect from him, and which if not accorded is certainly likely to injure the undertaking.

It is idle to urge that the extra work can be performed in his leisure time. The local authority employing him has a right to expect him to employ his leisure in such recreation as will bring him "fit" to his work next day.

Nor, finally, is it compatible with his duties that he should from time to time absent himself from his work.

If any municipal engineer is in doubt as to the course that will lead most surely to his own preferment, let him reflect upon the "stay at home" instincts which characterise those of his colleagues who are drawing the biggest salaries in the profession.

Tramway Track Sanding.

The case of the Corporation of the City of Dublin *v.* The Dublin United Tramways Company, which was duly noted in the Electrical Review some time back, has already borne fruit. Our readers will recollect that it was there decided that a tramway company, who are bound to keep the roadway between the rails in good order and repair, must lay down sand from time to time in order to prevent horses slipping. On Wednesday, December 19th, a carter named M'Clure sued the company for damages occasioned by their negligence in not keeping the tramlines in proper repair and condition, whereby a horse driven by the plaintiff fell, and the plaintiff sustained serious injuries. The Recorder, before whom the case was tried, said that in accordance with the decision already referred to the company were bound "to sand the line through the streets and keep it in proper condition." He gave judgment for the plaintiff for £8 8s. and costs. We are not aware that this important question has arisen in connection with tramways in English towns. The problem can only arise where mechanical traction is used for propelling trams, inasmuch as the horse tramway company will naturally keep the track in the best of condition for the sake of their own steeds. It seems a little hard that an electric tramway company should be held liable in damages for omitting to lay down sand, as it is by no means clear that the highway authorities themselves could be penalised in such a way.

ELECTRIC AUTOMOBILES.

A Retrospect and Forecast.

By HENRY F. JOEL.

The advance of this new industry since November, 1896, when "The Locomotives on Highways Act" came into operation, has run on parallel lines to that of the electric light industry since its emancipation.

The success now achieved is the result of much perseverance in perfecting details. Three years ago motors, batteries, controllers, &c. in use for electric tramcars, were well-digested apparatus, but the necessity for absolute reliability of every contact, connection, and screw, in electric automobiles under the strain and excessive jolting they are subject to on common roads was not apparent, and has needed the most careful consideration and painstaking attention, and in the process the modern "electrical, mechanical, chemical, and coach building automobile engineer," (and I might add cycle expert) has been evolved. I venture to say that the running of electric tramways and railways on smooth roads is an easy task in comparison. On one day's run of 30 miles, in one of the first electric carriages made a few years ago, there were 19 breakdowns due to disruption of battery connections, loss of contact in the controller, loosening of brushes on motors, and other troubles, necessitating stopping on the public road, and demanding the cutest knowledge to find and repair the faults as best one could in the presence of an extremely interested crowd of sightseers and their friends, with the cabmen passing sarcastic and uncanonical remarks. The next day the same carriage went the same journey with only two stops, and the experience gained by three years of such trials has brought the electric automobile to its present position as a practical electrically-propelled carriage, suitable for use on common roads, in any weather, at the shortest possible notice—instance, the recent trials at Chislehurst.

The electric automobile is now a marketable commodity, and from the many advantages inherent to it must of necessity become of enormous importance to the commercial industry of this country.

To such men as Reckenzaun and Immisch in England, and Jentaud in France, is due the inception of the modern electric carriage. Reckenzaun, unfortunately, did not live to see his work perfected, and no doubt the great strain of such pioneer work shortened his life. Faure, King, and Reynier made the stepping stones to the modern electric car storage battery, and what the improvements in the battery mean may be gathered from the following :—

The E.P.S. Company's list of 1888 gives the weight of "the vehicle battery" tramcar cells, Type T, at 66 lbs. for an output of 120 ampere-hours; now a battery giving a practical output of 140 ampere-hours weighs only 23½ lbs., or one-third the weight. In a battery of 40 cells (the number used in electric carriages) this would give :—

$23\frac{3}{4}$ cwt. against 8 cwt.,

or a saving alone of over three-fourths of a ton.

Improvements in the motor are equally great. A few years ago electric motors to give 2 H.P. at a reasonable efficiency weighed over 5 cwt., and ran at speeds of about 800. Electric motors are now made of special design for electric automobiles and weigh only 1 cwt., or one-fifth of the former weight, and run at a speed of only 600 to give 3 H.P. at high efficiency.

With the controllers also, the cumbersome and ineffective commutating switch and controller with uncertain contacts and much sparking, weighing about 1 cwt., is now replaced by the improved controller weighing about 14 lbs., and giving no trouble after many months' use, and further giving all the changes of speeds, change of direction, brake, stop, and grouping of cells for charging by means of the one operating handle only.

A brief criticism of the earlier attempts to produce successful electric carriages will assist us in making a forecast of the future.

The weight of the carriages, cabs or omnibuses were out of all proportion to the weight of the power-giving battery carried by them. The following are examples :—

	Vehicle only.	Battery only.	Percentage of power (battery) to combined weight.
Omnibus (London Electric Omnibus Company)	2·5 tons	·75 ton	23 per cent.
Omnibus (Electromotive Force Company)	2·2 „	·67 „	23 „
Jentaud Waggonette (France)...	2 „	·6 „	23 „
Electric Carriage and Wagon Company, of New York, hansom cab	1·1 „	·4 „	27 „
Morris & Salom, U.S.A., electric brougham	1·1 „	·45 „	29 „
Approximate limit of distance the above carriages will run on one charge is stated to be	—	—	25 miles
Contrast this with electric dog-cart and voiturette at Chislehurst trials, England, 1900 ...	·4 „	·4 „	50 per cent.
Distance that these English carriages have run on one charge	—	—	50 miles

The voiturette of "The National Motor Carriage Syndicate" has an authenticated run from London to Brighton on one charge, a total distance of 53 miles, and has run the same journey on several occasions.

In these examples I have not given the load-carrying capacity, as the distances run varied.

In the old electric carriages there was unnecessary waste in resistances used for control; in magnetic clutches not required at all; in complicated spur tooth and worm gearings, and in the inappropriate design and construction of the vehicle, due to want of experience of both electricians and of coach builders. One of the chief defects in this respect was the small diameter of the wheels, and this, especially in the heavier vehicles, omnibuses, &c., experience has shown to be most detrimental.

The defects I have outlined explain the early failures. One instance is recorded of an omnibus that was tried on muddy macadam roads in London. It weighed a total of over 4 tons, of which the battery was stated to be 70 cells of 23 lbs. each, or a total of 1,610 lbs. This is about 18 per cent. effective power weight. The wheels were of very small diameter, and the tractive effort under the circumstances must have required a pull of about 200 lbs. per ton and 12 H.P. from the batteries, or a discharge of about 100 amperes from batteries whose normal rate was probably only 20 amperes. No wonder it stuck in the mud, and the batteries were destroyed. In the electric cabs the total weight of the vehicle, battery, motor, and gear was given as about 2 tons to carry 4 cwt. of passengers and driver, or a proportion of one-tenth effective load to vehicle.

Contrast the weight of these vehicles with a bicycle weighing only 26 lbs., and carrying 140 lbs., an effective load of five times the weight of the vehicle.

In the cabs the weight on each wheel was about 10 cwt.; on a bicycle the weight on each wheel is about $\frac{3}{4}$ cwt., and bicycle tires will last for some 5,000 miles' run, whereas the wear and tear on the rubber with the heavier weights will only give a tenth of the life of the lighter carriage.

The improvements made apply to every part of the electric automobile, viz., the carriage, battery, motors, and gear. In America the use of bridged steel tubing makes an extremely light vehicle of great strength, and is a great advance upon the solid edge plates, often of inferior iron, used by coach builders. Specially drawn sectional steel channels and angles allow of more easily building the carriage body to them than tubes, and, if well designed, give the required strength as well as the flexibility necessary to soften the jar of starting and braking.

The use of steel framing and aluminium for panels in place of the heavy timber construction is another step in advance.

An umbrella will keep off the rain, and the covers of closed carriages do no more, and should be made as light as possible.

The size of the wheels has recently received special atten-

tion. Dr. Luxenberg has written a most interesting article* which deals with this problem, and has shown that for level roads the resistance to traction and the energy consumed are within certain limits inversely proportional to the diameter of the wheels of the car, and he advises the use of wheels of from 3 feet 3 inches to 5 feet or more in diameter. He estimates that the use of these larger wheels in place of wheels of 2 feet 6 inches to 3 feet diameter usually used, would effect a saving on the level of about 40 per cent., but this would not apply to hill-climbing, where the power must be increased almost in proportion to the gradient, necessitating either a slower speed or a great reserve of battery power. Wheels of a diameter over 3 feet become difficult to reduce in speed.

The deduction of M. Dupuit as the results of careful experiment, viz. : "The resistance is inversely as the square root of the diameter of the wheel" is, in my opinion, a much safer guide. It is obvious that wheels of 3 feet diameter bridge the ruts and depressions of bad roads much more than wheels of 2 feet diameter, and with the heavy weights of electric cars the sinking and re-lifting of the car means great loss of power.

In France, as the result of actual trials, front-wheel driving is preferred as being more economical of power, and front-wheel driving is also advocated in Austria.

In America, Belgium, and in this country, rear-wheel driving is the rule.

Here again the diameter of the wheels is of importance, if the front wheels are made of the same diameter as the rear wheels, both being of good size, and if the front wheels are connected to the rear wheels by a flexible "perch pole" (known as a "reach" in the States), so that the power is transmitted directly from the back wheels to the front wheels and not through the springs of the carriage body, there does not appear to be any advantage either way and the convenience of applying the power to the rear wheel, where the greatest weight is usually carried, more than counterbalances any small gain as between trailing and pushing. The original bicycles were front-driven with large wheels and small trailers; the modern safety is rear-driven with both wheels of the same diameter.

Pneumatic tires *versus* solid rubber tires have been practically investigated in America by Mr. R. A. Fliess, who found that a comparison of the results obtained while travelling over the same ground—good hard asphalte streets—at the same speed—about 9½ miles per hour—was 80·27 watt-hours per ton-mile for solid tires as against 89·42 watt-hours per ton-mile with pneumatic tires, an advantage of about 10 per cent. On the other hand, Michelin's experiments in 1898, show that pneumatic tires require less tractive effort, and especially on bad roads with varying gradients, and also as the speed increases. Pneumatic tires, owing to their greater resiliency, materially add to the comfort of the passengers, are much better for the batteries and motor, and the general opinion is they save power, but they are more expensive and not so reliable as solid rubber tires.

The power transmission gear, although not materially altered, has made some progress in details of the chains, and in the use in some cases of raw-hide spur tooth pinions, and also of roller bearings. There is no great difference in the type of gears in France, America, and in this country; all use the toothed wheel and pinion, and the bicycle or other chains. The more experienced practice with petrol cars, as in the case of bicycles, appears to favour the bicycle chain; it certainly has the great advantage of adaptability under varying movements of the centres.

Many of the electric carriage builders in France and this country are adopting the double motor drives, one motor to each front or each back wheel, and it has the advantage of simplicity in saving the balance gear and the friction of the live axle; it is most convenient for regulating the control, and gives a greater reserve of power applied exactly at the point of greatest resistance when hill-climbing. Another advantage is, that in the event of derangement of the gear of one motor, the other motor can run the carriage. The use of a springy and separate underframe, independent of the carriage, to carry the electric motors between the two axles is another step in advance; the vibration of the motor is not communicated to the carriage, the motors with their frame are readily detachable from the carriage for inspection or use in another carriage, having the same distance between the axles, and the underframe constitutes the flexible "perch pole" before mentioned.

In Austria, and also in America, the use of electric motors constructed directly in the hubs of the wheels, in the two front, or all four wheels, is advocated, but as they have not had extended trials, it is difficult to say what advantages can be obtained, especially as the motors are geared down to drive the wheels by somewhat complicated tooth gearing, and except for the cushions formed by the pneumatic tires, are subject to all the concussions of the roads.

The question of the design of the carriage has received much attention, and particularly recently. The great object has been to make a carriage that is comfortable and safe, *i.e.*, with a low centre of gravity and broad wheel base, that can be easily steered and quickly stopped. In this latter point electric vehicles have the very great advantage over all other types of motor cars, as the electric brake is so convenient, unfailing in action, and quick to stop the carriage, that the mechanical brake is hardly applied at all; and last, but not least, it must be elegant in appearance, so as not to appear to require the horse to complete it, and yet not to be like the "piano box run-about," or the "coal scuttle hansom," of America, or the lorry type of cab of London and Paris. This question of elegance may now be considered as solved, the disposition of the batteries under the seats, making the front wheels of the same size as the back, the use of "Akerman" steering gear, and consultation with the carriage builder as to design, have combined to produce some really beautiful electric carriages in this country.

The improvements in electric motors are well known to readers of the Electrical Review, and need not be enlarged upon. Making them multipolar to save weight, to obtain large polar surface and decrease of non-active wire, and the use of aluminium in their construction, as well as more careful design to stand an overload often of 100 per cent. or more, and to over-run their normal speed without sparking, are all points that have been most carefully studied, and adapted to the special requirements of electric automobiles.

The improvements in storage batteries are mostly improvements in the mechanical details of the supporting grids to allow full expansion of the paste, and to avoid sulphating, in the mechanical support of the plate, and also in the increase of the specific gravity of the electrolyte, from 1,050-1,200 to 1,150-1.300, and the consequent decrease in volume and weight and prolonged E.M.F. The use of both "Planté" formed type, and of the "Faure" or pasted type, are advocated by their different makers, but for electric automobiles the pasted and lighter form of electrode has a great advantage.

The better support of the pasted electrode by moulded, porous, earthenware divisions is of interest. Improvements have been made in the chemical composition of the depolarising paste and the mixture of the paste with other materials to make it more coherent, and as a result batteries for traction purposes, whilst giving three to four times the output for the same weight, are now much more durable, and, indeed, from my own experience I have known batteries (Rosenthal) after two years of very rough use in a motor car still giving within 10 per cent. of their original output, with hardly a trace of sulphating. The use of zinc with peroxide of lead gives a higher E.M.F. (Wheatstone gives this as 2·446 volts) than lead and peroxide of lead, but necessitates the use of porous pots. Such a battery has been introduced by the Lee-Coll Company and others. This battery has the advantage in common with other types of porous cell storage battery, that it can be quickly charged and the whole energy stored in one to two hours, that is to say, during a stop for lunch.

Zinc peroxide of lead battery of 120 ampere-hours. — Charge 90 amperes for two hours.

And can be discharged at 20 to 60 amperes, whereas the best form of pasted type must be charged at 20 to 40 amperes, but is more efficient, gives a greater output for the same weight, and is more durable.

This property of being quickly charged is of immense importance, and is a decided step in advance. The

* See Electrical Review for November 30th, 1900.

problem of being able to make a specially coherent and tough pasted electrode to stand charging in such a short time without disruption is not an impossible one, and I hope will soon be solved. The connections of cell to cell, the protection of the cells from damage by vibration, and other such details are now all fairly perfect, and it is a fact that batteries are now made giving under favourable conditions 15 watt-hours per lb. of complete cell, and 20 watt-hours per lb. of electrode of guaranteed durability. This represents a gain in output of over 400 per cent. in the last ten years.

The questions of speed and control also come in for criticism. In France the limit of speed is fixed at 12½ miles through traffic and 18½ miles on the open road. In America the speed is taken at 12 to 14 miles, and in England at 12 miles per hour.

As is well known, electric automobiles can be run for short periods at very high speeds—as much as at the rate of 60 miles an hour—and 20 miles an hour is easily attained, but the speed of 12 miles an hour is the present limit, as beyond that speed windage (unless the vehicle is specially designed) becomes a great power eater, the power required increasing within limits, almost as the square of the speed.

It is difficult to class the different methods for controlling the speed. The main system is what is known as "the series parallel system," and consists in grouping the batteries in parallel, or series, as increase of speed is required, or grouping the motors in parallel, or series, with the same object, and also in combining the two. In America, with single motors, they sometimes use double-wound armatures and different windings of the fields for regulation. The system in favour in this country is to regulate by altering groups of cells, say, with 40 cells in four sets of 10, arranging them in four parallel for slow speed, then in two groups of 20 for more speed, and all in series for full speed.

A system of control has recently been introduced which appears to be a great improvement. It is: Starting on the basis that the greatest power is required for hill climbing, the motors are then in parallel, and are worked at their normal speed and highest possible efficiency; the limit battery discharge is not exceeded whilst the carriage is geared to ascend the hills at half speed. For running on level roads at higher speed the motors are overrun, and for slow speed in traffic the motors are coupled in series. This system has great promise, it is simple, and apparently meets the necessities of the case.

A most interesting feature adopted in recent carriages is the recuperation or back-charge given to the batteries when the carriage is running downhill, as much as 25 per cent. of the current taken in ascending is returned to the batteries when the carriage is descending, but for a much shorter time. This, however, is a great gain on a long journey, as it restores the battery to the fullest possible E.M.F. for the time.

The progress I have briefly sketched and the improvements made during the last three years has enabled a convenient, elegant and practical type of electric carriage to be made that will run from London to Brighton on one charge of electricity. With a vehicle weighing only 4 cwt., battery and motors 8 cwt., and passengers 3 cwt., or 15 cwt. in all, experience shows that such a carriage can be run the 50 odd miles, through hilly country, for under 100 watt-hours per ton-mile, which, at 3d. per unit for electricity, comes out at about ¼d. per ton-mile, or under 1¼d. per mile for two passengers. This is the cost of electric energy only, and compares most favourably with the cost of petrol, steam, or horse-drawn vehicles.

Mr. Fliess (in America) has, after most exhaustive practical trials, proved that tradesmen's electric vans carrying 600 lbs. of parcels, can be run at less cost than horse-drawn vehicles. The actual results obtained were:—

Cost per ton-mile horse van, 33 miles per day, two horses, including all charges	= 7½d.
Cost per ton-mile electric, 33 miles per day— current at 1½d. per unit, including all charges	= 2½d., at 2½d. unit = 4d.

M. Georges Forestier, as the results of actual trials in France, gives:—

Cost per ton-mile steam lorry	= 2d. to 4d.
Cost per ton-mile petrol lorry	= 3d. to 6d.

The cost of electric carriage, with improved and more efficient vehicles, such as I have indicated, will be less than given above, whilst the advantages of control, great brake power, absence of vibration, smell and noise, and increased comfort are all on the side of the electric automobile. Another great advantage is that the electric carriage does not frighten horses or cause them to shy to anything like the same extent as some petrol cars, the disadvantage being the difficulty of obtaining a fresh charge on the batteries. This difficulty is now being rapidly overcome by the readiness of the electric supply companies in towns and in country districts to provide motor houses and to re-charge at all times, day and night, and at a reasonable cost. Charging stations are even now open in every district in London itself and at Chelsea, Hampstead, Richmond, Windsor, Watford, Stratford, Leyton, Harrow, Chislehurst, Woolwich, Weybridge, Willesden, Greenwich, Putney, all on main roads leading from London, whilst still further out there are charging stations at Guildford, Crawley, Woking, Tunbridge, Chelmsford, Luton, Cheltenham, Reading, Maidenhead (and many other towns on the River), Brighton, Southsea, Hastings, Oxford, Bath, Bedford, &c., and so on throughout the country.

There is an Association of Electric Carriage Builders being formed especially to obtain and increase the facilities for re-charging, and whose first object is to provide maps, showing where the charging stations are situated. In the near future there is likely to be as good an accommodation in that respect as there was in the old coaching days, of stables and food for the horses. Indeed, many large hotel proprietors in county districts are installing electric power for re-charging, or, alternatively, relays of portable ready-charged batteries can be easily arranged. It is confidently expected that electric carriages will take part in the coming 1,000 miles' run organised by the Automobile Club of Great Britain.

In advocating the electric automobile it is not contemplated that it will supersede the horse, or petroleum, or steam cars; all have their advantages. The requirements of the increasing growth of population demand more facilities for rapid travelling, and electric automobiles are eminently suitable for public conveyances in towns—for cabs, omnibuses, &c. (In London alone there were licensed in 1899 7,569 hansoms, 3,634 Clarences, 3,626 omnibuses, 1,381 tramcars.) They are also equally well adapted for light tradesmen's delivery carts—(many of the large trading firms have their own electric supply stations)—for doctors, travellers, mail vans, &c. For private purposes, Victorias, dogcarts, &c., and for coaching trips, all who have ridden on an easy-going electric car at the rate of 12 miles an hour through the country speak in high praise of the exhilarating feeling such travelling gives. Daily electric coaches to Brighton, Southsea, Epping, Oxford, Windsor, or other places are now easily attainable, and will come; and brakes for pleasure parties and many other such uses are evident to the thinking mind. The demand for our Colonies must be great; electric carriages are more suitable for use in hot countries such as India than those propelled by any other power, and there is hardly a part of the world where electricity is not obtainable, in many cases far more easily than in this country.

In Great Britain the progress of all automobiles was retarded by the Highways Act, and it is only since that Act was amended in 1896 that the industry has had a fair start, and, unfortunately, at its start the company promoter did his best to cripple it by inflated capitalisation and grossly inaccurate statements in prospectus by experts and financiers. In America electric carriages were being made in 1894. The *Chicago Times Herald* organised trials of electric carriages in November, 1895, and it is interesting to note that the limit of a run at that time on one charge was 20 miles, and apparently only two electric carriages competed, as against six gasoline cars. In the recent automobile show in New York (November 3rd, 1900),* there were 70 electric carriages, 73 steam, and 81 gasoline, and the electric carriages showed a great improvement, the limit of a run on one charge being given at 50 to 80 miles. An electric carriage won the prize for quick stopping. Whilst running at 10 miles an hour it was stopped in 5 yards. No

* See ELECTRICAL REVIEW for November 30th, 1900.

horse-drawn carriage going at this speed could be stopped within twice that distance.

The electric automobile industry in America is assuming very large proportions, for 200 electric cabs are now running in New York alone. Something like 100 firms and companies with some millions of capital, and employing some thousands of workmen, are engaged in the manufacture of electric carriages and accessories. Many American cars are imported into this country.

In France, anyone who has visited the annual exhibition held under the auspices of the Automobile Club of France, where some 300 cars are exhibited, must admit the immense advance of that country, and the elegance of the carriages.

Special cab trials were held in Paris in 1898, and also 1899. In the 1899 trials 10 vehicles competed, 9 being electrical and 1 petroleum. This speaks for itself. Some hundreds of electric carriages are in daily use in Paris, but they mostly follow the type of electric cab introduced in London, which experience has shown have many disadvantages, the great weight of the vehicle being one of the worst features, and causing great wear and tear, as well as being most uneconomical. At the recent great exhibition in Paris (1900), there were many examples of elegant, light, and economical electric carriages where the proportion of battery weight to vehicle weight was on a par with the recent English practice, and it is noteworthy that in May of 1900, a specially designed electric car made on the B.G.S. system with 54 per cent. effective weight, ran the extraordinary distance, on fairly level good roads, of 160 miles on one charge of electricity. At the request of a private firm(!) of motor carriage builders in America, made to the American Government, the U.S. Consuls in different European countries collected the following information, viz. :—In the consular district of Paris it is estimated there are 30,000 automobiles, petrol, steam, electric, &c., in daily circulation. In Germany there are 20 electrical omnibuses in service, and more are being built as rapidly as possible, as well as other types of electric vehicles, and it should be remembered that Germany is the home of the Otto, Daimler, and Benz petrol engines. In 1899 there were 32 makers of petrol cars in Germany, there are 18 or more firms manufacturing motor cars in Belgium. In Austria there are several firms making electric automobiles, batteries, &c., and in Italy, Netherlands, Russia, and other countries there is the same activity, and all have the start of this country; but let us hope that we shall now take our place in the markets of the world with this new industry, as we did with cycles, and in the past with the steam locomotive.

Four or five excellent electrical and automobile periodicals, advocating the new industry, have been started in this country since 1895. The daily press are taking much interest in it, and we have an extremely energetic Automobile Club. Although we have started late in the race, we are pushing on, and such trials as those recently held by the Automobile Club at Chislehurst, and previously at the Agricultural Hall, have established the merits of the English-made electric automobile as of sound practical utility. The economy and efficiency of electric power is admitted; it is rapidly superseding steam and other power on our tramways and branch railways, and we have the reasonable assurance that the future of the electric automobile will be of immense extent, and afford employment to thousands of British workmen. Electricity is charged with this useful mission; amongst its many useful missions it is for us, its exponents, to do our part, and in the next few years we shall see hundreds of elegant electric carriages and sightly tradesmen's vans, strong, light, economical, and wonderfully handy, in use in our cities and on country roads. Streets will then be cleaner, and the conditions of life more pleasant and healthy.

ELECTRIC TRACTION AND TRANSMISSION IN THE NEW CENTURY.

By PHILIP DAWSON.

THE applications of electricity are becoming more important every day, and there is practically no industry at present into which it does not enter in some form or shape. For the production of light, in chemical and metallurgical works, as motive power in mines and works of all sorts, and last, but nor least, for transmitting power over large areas from the mouth of the coal pit or from waterfalls, and for hauling trains and running tramways and vehicles of all kinds, electricity reigns supreme. The nineteenth century might, perhaps, have been called the century of steam; it is not improbable that the twentieth century will be known as that of electricity.

A retrospect of the surprising progress of the last 10 years is interesting and instructive. England, which produced the founders of dynamo design and some of the greatest electricians, such as Lord Kelvin, the late Dr. John Hopkinson, Clerk Maxwell, not to speak of Faraday, now purchases a large portion of her electrical machinery from the United States, Germany and Belgium. Not so many years ago we constructed the best electrical machinery, and even exported the same to America.

If we consider such an important branch as electric traction, some of the very first electric lines laid down on a commercial scale were in Great Britain in the early eighties, as at Brighton, Blackpool, Bessbrook and Newry, and Portrush, before America had done anything. It is probable that the electrical industry of this country has been stunted in its growth by the Electric Lighting and Tramways Acts. It is true that some of the obnoxious restrictions have been removed, but meanwhile foreign manufacturers have outstripped us.

To England belongs the honour of the first overhead and underground electric railway, viz., the Liverpool Overhead and the City and South London. Both these lines, after nearly 10 years' service, are as good to-day as when they were built, and yet we are only now catching up with other nations in electric traction.

Ten, even five years ago, the British public, of many millions, "mostly fools," to quote Carlyle, were very prejudiced against all forms of electric traction. It was probably too novel, and English people do not like new ideas; we are a conservative race. Only a few years ago nearly all the technical press, with few exceptions, was against the trolley system, but fortunately things have changed. What are Londoners, the most conservative body of people, doing? The London County Council but a few years ago would not hear of such a thing as electric traction, and protested even against the very idea, stigmatising the men who were foresighted enough to see the advantages of electric traction as greedy capitalists, grasping at dividends, who wanted to disfigure the streets of London. Now that same County Council is proposing to run tramways up Victoria Street and down the Embankment. The writer suggested this idea in the REVIEW nearly five years ago, and an illustration was published showing the Embankment with centre brackets surmounted by arc lamps, and a double line of electric cars. Then the suggestion was met with ridicule; now it is taken up.

A little more observation on the part of the public who travel abroad would have done much to hasten the introduction of electric traction into this country. How many Englishmen travel in the States or know that country as well as the average American knows Great Britain? We read of what is done in America, and generally do not believe what the Americans tell us. A visit there would do most of our works managers, engineers, local authorities and financiers much good. Everything America does is not good, nor should we blindly copy her, but she has much to teach us. All American firms have several of their owners, directors, engineers or other employés over in Europe at least once a year. They come on business on purpose to see if there is anything they can learn, and to find out what markets there are for their wares.

Prof. Perry, in his able Presidential address before the Institution of Electrical Engineers, stated that the visit of the Institution to Switzerland was a revelation to almost all who went. Yet what they saw on that occasion, although unknown in England, was not specially novel from a Swiss point of view, but, on the contrary, had been in the process of development for some years. Not a thing is done in this country which is not studied or known by Swiss engineers. A little more information as regards the doings in foreign countries would do us no harm.

Having briefly examined the past and some of the causes which are responsible for our not occupying the position amongst the nations which by right should be ours, it is interesting to consider the present position of the various electrical industries.

In this connection figures showing the relative positions of the various branches are useful. The development of electrical, as well as other mechanical industries, has, probably, from physical reasons, been more rapid in the United States than in any other country.

Especially is this the case as regards electric traction which has grown phenomenally within the last few years. This is chiefly due to the absence of good roads and the necessity for cheap and rapid intercommunication caused by the rapid growth of towns. Also they are not hampered by Board of Trade rules and costly Parliamentary Bills.

In 1890 there were only slightly over 2,000 miles of electric railways or tramways in existence in the United States. On these were running approximately 5,000 motor cars. Now there are considerably more than 20,000 miles of electric tramways and railways in America, over which are operated 50,000 electric motor cars.

The total capacity expressed in kilowatts necessary for operating the electric cars attains 800,000 KW. Reckoning all the energy available in American central stations for all purposes, including lighting, power transmission, and traction, there must be certainly installed well over 2,000,000 KW.

The total capital investment corresponding to the above cannot fall far short of two hundred millions pounds sterling. In the following table an approximate comparison has been attempted between Germany and Great Britain in 1895 and 1900. The figures are only approximate, and do not include very small and insignificant stations. From it will be seen that as regards the total electrical power available for all purposes, we have now well caught up with, and, in fact, are ahead of Germany :—

TABLE GIVING COMPARISON BETWEEN GERMANY AND GREAT BRITAIN.

Items.	1895.		1900.	
	Germany.	Gt. Britain.	Germany.	Gt. Britain.
Total number of stations of all kinds	206	140	578	300
Total power installed in KW. for all purposes ...	57,000	90,000	230,000	250,000
Capacity of power installed in KW. for traction only	5,300	3,500	60,000	50,000
Miles of track electrically equipped	600	100	2,400	1,000
Number of motor cars running	650	120	5,600	2,500
Total capital invested in traction, lighting, and power transmission plants	—	—	£40,000,000	£35,000,000

Having briefly investigated the actual condition of things, it may be of interest to make some speculations as to the probable future. This can only be done approximately, and the safest method is to use what has been done in the past few years as a basis.

If we go back to 1894 and take the average rate of increase during five years, 1894 to 1899, we have :—

——	Germany.	England.	United States of America.
Miles annually newly constructed	427	166	2,200
Number of new motor cars put in service annually	1,050	376	3,000
Power in kilowatts newly installed annually	10,500	7,400	100,000

To get a better idea of the average increase in electric traction in America we have to go back to 1889 and take the average increase during the last 10 years, in which case we find that the average annual mileage constructed for electric traction during the last 10 years in the United States has been about 2,000 miles. The number of motor cars put into operation have been 3,600, and the power in kilowatts installed to run the cars has been 70,000 KW.

Taking the increase between the end of 1898 and 1899 in Germany and England, we find :—

——	Germany.		Great Britain.	
	—	Increase.	—	Increase.
		Per cent		Per cent.
Miles of track equipped ...	500	28	340	60
Number of motor cars put in service	2,300	74	500	33
Total capacity in kilowatts of power installed	28,000	107	12,000	43

At the present moment there are under construction in Great Britain some 500 miles of electric tram and railways, and Bills for about 504 more miles have passed through Parliament. In Great Britain there are at least four cars per mile of track, and about 20 KW. station capacity is installed per car equipped. Then, assuming that the above rate of construction will continue for the next five years, which, from experience in other countries, is a fair supposition to make, before the year 1905, 2,500 miles will be equipped, 10,000 motor cars will be put into service, and 200,000 KW. will be installed for tramway traction alone.

Considering that lines such as the Manhattan Elevated Railway in New York, which is now being converted into an electric road, will require a station capacity of 60,000 KW.; and comparing our metropolitan and suburban roads, which will have to be run electrically sooner or later, we may safely assume that for traction purposes of all kinds a capacity of 400,000 KW. of central station plant will have to be installed in the United Kingdom within the next five years.

Taking Great Britain and the United States, we find roughly that the population of the latter is 75 per cent. greater than that of the former, and its superficial area 30 times greater. The total electrical power for all purposes is 10 times as great, there is an electric railway mileage 20 times as long with 20 times the number of motor cars running. Again, comparing the United States with the whole of Europe, their superficial area is about the same. Europe has five times the population of America, and yet the mileage of electric roads in Europe is only 25 per cent. of that existing in the States, which has seven times as many cars running. The conditions that obtain in the two countries are totally different, but yet these figures are interesting. A great deal has been said lately about American competition ; here at least is one reason (as regards electrical machinery) why America has a great advantage over our own manufacturers.

As regards Germany and its progress, some interesting figures are available. The number and capacity of stations referred to does not include private installations, of which there must necessarily be a great number. On the average nearly 82 new plants have been put in every year for the last five years, having an aggregate capacity of 36,400 KW. The increase last year, considered by itself, was 126 new power stations, containing a total generator power of 86,000 KW.

As regards Great Britain, it is interesting to note that of the total 250,000 KW. for all purposes installed in this country, roughly 100,000 are installed in London and its suburbs. Of the total 50,000 KW. available for traction, nearly 13,000 KW. are to be found in London. This is due to the main line railways, which have been equipped so far, with the exception of the Liverpool Overhead, all being there.

From careful investigation it is probable that eventually at least half the total power installed will be utilised for traction purposes.

From the large expenditure involved it is evident how important it is to most carefully examine all the conditions that a new plant may have to fulfil, as well as the local conditions which obtain.

There are at present in Parliament nearly 70 new lighting schemes and 50 new traction schemes, besides half a dozen power schemes for distributing energy from the pits' mouth over large areas.

The future of electricity in the United Kingdom is very bright. Over-production and over-speculation are not to be recommended. The recent drop in German electrical securities is largely due to this cause.

But while the future as shown, as far as Great Britain is concerned, seems bright, there is a grave danger that unless reforms are instituted, British goods and engineers may not be exclusively employed. Prof. Perry, in his presidential address, stated that our present unsatisfactory position was largely due to the absence of properly trained and educated engineers. Practice in the shops is necessary, but without sound technical education, such as is found in Belgium, Germany, Switzerland and the United States of America, it is worse than useless.

In considering the position of electric traction and transmission in the new century, it is useful to investigate the present practice which exists in different countries.

As regards electric traction, there are two portions to be considered, namely, the track and conductor and the power station and distribution system.

At present, as far as conductor systems are concerned, only two systems are actually practically in use on a large scale for tramways, the trolley and the conduit. Two more have been used tentatively ; they are the surface contact and the accumulator.

As regards main line railways, the third rail is always adopted. What will be in the future the system generally used ? That is difficult to answer outright. In the light of our present knowledge, we would say that in very busy thoroughfares with enormous traffic and of considerable length the conduit will be installed. That the conduit gives satisfaction under such conditions is beyond doubt. With this construction it depends entirely on the traffic to justify the exceedingly heavy initial expenditure and greater maintenance.

In nearly all other cases the trolley will be installed. There may be exceptional cases where the mixed system of accumulators and overhead system may be advantageous, but such cases will no doubt be very rare. At Hanover this system was successful ; in Berlin the reverse was the case.

As regards the number, size and type of power stations to be adopted, each individual case must be most carefully considered.

The relation of power producing expenses, total working expenses, capital expenditure, and interest on sinking fund on some of the various possible alternatives must always be most carefully examined and compared. A power station should, of course, be situated as near to the centre of distribution of the whole system as is economically possible, all other things being equal. The ground on which it is located should be easily accessible by rail and water, so as to get fuel quickly and cheaply. A good and copious supply of feed and condensing water should be easily obtainable, and the ground such as not to necessitate heavy expense in sinking the foundations of the various buildings.

Where the station is fairly central, and the lines do not reach much beyond three or four miles from the power house, continuous current generators, with boosters to supply the distant and hard-worked lines, may advantageously be used. When the traffic is very dense, and the total power required exceeds from 4,000 to 5,000 KW., it will generally be found that, as far as Great Britain is concerned, three-phase generators, with sub-stations and rotary converters, are to be preferred. Where three-phase plant is used (with few exceptions) no continuous current generators should be installed, the requisite continuous current being supplied by rotary converters even for use in the station itself, as the reaction of continuous current generators through the line on to the rotary converters may make regulation difficult.

Where the station is centrally situated, but with one or two lines going out a long way, continuous current generators may be used. One or more polyphase generators, preferably driven by continuous current motors in the main station, can send high tension currents to rotary converters in sub-stations near the extremities of the outlying lines.

In a small system, when the station is centrally located, gas engines, driven by water-gas made on the premises, and in parallel with accumulators, may, in many instances, prove effective, especially where coal is expensive. It is the cost of the coal which will indicate whether in such a case gas or steam engines are the more advantageous. A gas plant generally costs about 25 per cent. more than a steam plant, but the coal and wages bill with gas are less than with steam. To decide on whether steam or gas is to be used, the entire cost of production should be compared in both cases with the extra cost of gas due to larger sinking fund and interest added, arising from the greater capital expenditure required by a gas plant. The use of blast furnace gas has of late found great extension, and great progress in this direction is to be expected. In this connection the able articles which have appeared in the columns of the ELECTRICAL REVIEW on this subject should be carefully studied.

Where a small plant cannot be located centrally, a subsidiary battery of accumulators and a booster located in the battery sub-station may prove of great value.

The number of units for a power plant should be as small as is compatible with safe and economical working. Continental and American experience has led to the nearly universal adoption of large and comparatively slow speed engines.

It is interesting to observe how much more similar central station practice is becoming in all countries, and how it is tending toward a common standard.

Great Britain, which, owing to the predominance of the marine engine, was at one time practically wedded to the high-speed engine, is now largely coming to the direct connected slow-speed unit. Germany and the Continent in general have already adopted slow speed for a considerable period. America has, as is usual with this venturesome and go-ahead country, gone through all phases, finally returning to the direct coupled slow-speed type.

The science of engineering knows no nation or country, and will always be cosmopolitan. As in the design of steam locomotives, so in the design of electrical apparatus, a standard type will soon be reached.

In this connection there is still a very vexed point, and one which, in the interests of all concerned, should soon, and once and for all, be settled. Reference is made to the rating and standardising of electrical machinery.

With this end in view, it would be most desirable for consulting engineers, manufacturers and contractors to come together and to unanimously lay down a set of standard specifications, such specifications to embody the experience gained in all countries, and to, as far as possible, coincide with existing commercial standards.

The future is very bright. England can hold her own if she realises the causes which render foreign competition possible. We must not be self-sufficient, which can only be hurtful to us, in the industrial struggle which becomes daily more severe amongst the nations of the world. We have always been prone to undervalue our foes, and as Lord Rosebery said, "to muddle through somehow."

But this is a very dangerous procedure, and the sooner we realise it the better. We should not, as is too often the case, shut our eyes and bury our heads ostrich fashion, so as not to see the rapid advances made by other nations.

In conclusion, a word may be said about long-distance railways. Mr. Langdon in his paper the other week before the Institution of Electrical Engineers, rendered a great service in bringing this matter prominently before the British engineering public.

In this connection the experimental lines just about to be opened by the Italian railways present the greatest interest.

Two principal lines are now being equipped and are in an advanced stage of completion : the line of Lecco-Londrio-Chiavenna and the line of St. Felice Bologna. The former is 109 kilometres in length with a maximum grade of 2·2 per cent., and is at present run by steam locomotives. The latter is 84 kilometres long with a maximum grade of 0·6 per cent. The Lecco-Chiavenna line will be run directly by three-phase motor cars. Each motor car as shown at the Paris Exhibition, and built by Messrs. Ganz & Co., of Buda-Pesth, will weigh 50 tons and attain a maximum speed of 60 kilometres an hour. The goods train will be hauled by electric locomotives of 600 H.P. at a maximum speed of 30 kilometres an hour.

The electrical current will be transmitted by a three-phase system along the line at a pressure of 20,000 volts transformed down in sub-stations to 3,000 volts at 15 periods, at

which pressure it will be utilised by the motor cars. There are two overhead lines, the rails serving for the third conductor.

The Bologna line will be run by accumulator cars, and the results there obtained will be watched with interest. A similar experiment is at present being carried on by the Belgium State railways.

To conclude, there is little doubt but that as regards motive power, electricity in the new century will more than hold its own. Its applications to chemistry and metallurgy will increase, and its adaptation to lighting remain unchallenged. In no country is the outlook more rosy than in the United Kingdom, and it rests entirely with British engineers, manufacturers and contractors to see that they secure their proper share of the business.

TELEPHONIC TRANSMISSION.

Section 1.—We have lately received from Dr. M. I. Pupin, a copy of a paper reprinted from the *Transactions* of the American Institution of Electrical Engineers, which contains an account of some experiments conducted in his laboratory, and gives in an appendix an important addition to the mathematical theory of telephony. In another article in these columns there has appeared an account of his laboratory experiments on the effect of inserting inductance coils into a telephone line, which corroborate the accepted theory of transmission.* In the mathematical part Dr. Pupin gives a simple method of calculating the effect on an otherwise uniform line, of inserting inductive coils at equal distances along it. That such a system may be approximately equivalent to a uniform resultant line, whose resistance, capacity, and inductance, are the sums of those of the original line, and of the inserted coils or condensers, is, of course, known; and that it is not strictly equivalent was recognised by Dr. Muirhead in the construction of his artificial cables. Within what degree of approximation, however, such a compound line is equivalent to the uniform resultant line, has hitherto only been determined, we believe, in special cases; but Dr. Pupin's expressions allow the effect of inserting the coils to be readily calculated. The problem of this paper, viz., the possibility of improving the Birmingham telephone line by inserting leakage coils at the testing posts, is an application of Dr. Pupin's work closely following his methods.

In discussing the transmission of electrical disturbances over telegraph and telephone lines, the disturbance at the sending end is resolved into a group of harmonics of different periods, the problem is treated as if each of these harmonics were transmitted quite independently, and the disturbance at the receiving end is taken to be the sum of the disturbances due to the separate harmonics. This assumption reduces the initial problem to finding an expression for the transmission of a single harmonic of given period and amplitude. The expression for a disturbance of any form resolved into a group of such harmonics is then obtained by addition. The assumption that harmonics of different periods do not interfere with one another is very important. There is no reason to doubt that it leads to correct results in the case of copper wires suspended in air, but where solid dielectrics or iron form part of the system, as in the case of a submarine cable, it appears to be very doubtful. The results obtained by Messrs. Squier and Crehore on the Commercial cable, to which we referred recently, do not seem capable of explanation if harmonics are transmitted quite independently. The theory of submarine cable transmission in its simplest form, the K R law, depends on the assumptions that the resistance of the metallic conductor and the capacity of the dielectric are both independent of the current, *i.e.*, of the magnetic field. The former is certainly untrue in the case of bismuth, as was shown by Prof. S. P. Thompson. Moreover, the resistance and inductance are assumed to be independent of the frequency of alternation, which is known not to be true of the resistance, and is probably still less true of the inductance when there is iron in the circuit. For the present purpose of considering the effect of putting coils into a twin copper line with air or paper insulation, the assumption will be made that K, R and L are constants.

* Electrical Review, Vol. 46, p. 1039.

In telephonic transmission each of a group of harmonics, will produce at the receiving end a harmonic disturbance of its own period. The amplitude of each harmonic will, however, be reduced by transmission in a proportion depending on its period, so that the amplitudes of the received harmonics do not bear the same relation to one another as do those of the sent harmonics, and the resultant sound at the receiving end has a different timbre or colour from that sent. The set of received harmonics will also differ between one another in phase in quite a different way to the set of sent harmonics. This latter difference does not seem to affect the action on the ear, and the changes of amplitude are the only points necessary to be considered. The ratio of the amplitude of the harmonic at the sending end to that at the receiving end is called the attenuation of that harmonic. On the assumptions we are making the attenuation is independent of the amplitude, but usually varies very largely with the period. The quality of a telephone line is determined when the attenuation of the different harmonics is known. If it is small for some harmonics the sound will be loud but may be indistinct or drummy. If it is large, but has the same value for all harmonics, the sound will be low but the articulation clear. In a good telephone line the attenuation should not be very large, and should differ little for different harmonics.

Section 2.—The transmission of a line depends on a number of constants of which the resistance inductance and capacity are the most important. Besides these there may be leakage, and the leakage current may have inductance. Proposals to improve the lines are based upon adjustments of the values of these quantities, and have been made in three directions, all of which were originally indicated by Mr. Oliver Heaviside.

(*a*) To increase the inductance of a line, keeping the insulation good.

(*b*) In the case of a line whose inductance is low, such as a submarine cable, to insert non-inductive leakage.

(*c*) In the case of a highly inductive line to insert non-inductive leakage. Heaviside's distortionless line.

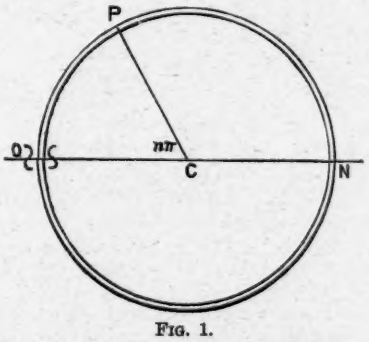


Fig. 1.

Consider the line of fig. 1 representing a twin line arranged in a circle. Alternating forces act at O which produce equal and opposite currents in the two wires. The distribution of currents in the system is symmetrical, with opposite signs on the two sides, about O N. At O and N each wire is always at zero potential, and the pair could be connected at those points without affecting the distribution. Either semi-circle O to N then represents an ordinary twin telephone line with a transmitter at O, and a receiver at N.

The resistance of each wire between O and N is R/2, so that the total resistance of the semi-circular loop is R.

The inductance of the semi-circular loop O to N is L.

The capacity of the semi-circle measured between the two wires, disconnected at O and N, is K, the insulation resistance between them r, and the self-inductance of the leakage l.

For harmonic alternations of period $2\pi/\omega$ the impedance of the loop is I, where $I^2 = R^2 + L^2\omega^2$; and the impedance of the leakage is i where $i^2 = r^2 + l^2\omega^2$.

The position of any point P is determined by the number n, where O C P $= n\pi$, so that O P $= n$ times the length of the whole line. Where y_n is the current at P, the differential equation is

$$d^2 y_n/d n^2 = (R + L\, d/dt)\{K\, d/dt + (r + l\, d/dt)^{-1}\}\, y_n.$$

This is satisfied by expressions of the form $\text{A}\ e^{\mu n + \nu t}$, where A, ν have any values, and

$$\mu^2 = (\text{R} + \text{L}\,\nu)\,\{\text{K}\,\nu + (r + l\,\nu)^{-1}\}.$$

Writing

$$\text{G}^2 = (\text{R} + \text{L}\,\nu)\,\text{K}\,\nu, \text{ and } g^2 = (r + l\,\nu)\,\text{K}\,\nu,$$

$$\mu^2 = \text{G}^2\,(1 + g^{-2}).$$

We will suppose the current y_0, at the sending point O, to be given. At the point N, where $n = 1$, the current has a maximum or minimum value, and $d\,y_n/d\,n = 0$ when $n = 1$.

If the impressed current $y_0 = \text{A}\,e^{\nu t}$, we have

$$y_n \cosh \mu = y_0 \cosh (1 - n)\,\mu,$$

and

$$y_1 \cosh \mu = y_0.$$

If ν is imaginary and is $\omega\,\iota$, μ is a complex quantity. Let $\mu = \alpha + \beta\,\iota$, where ι stands for $\sqrt{-1}$. Then

$$y_n \surd (\cosh 2\,\alpha + \cos 2\,\beta)\,e^{p\,\iota}$$

$$= y_0 \surd \{\cosh 2\,(1 - n)\,\alpha + \cos 2\,(1 - n)\,\beta\}\,e^{q\,\iota},$$

and

$$y_1 \surd (\cosh 2\,\alpha + \cos 2\,\beta) = \surd 2\,.\,y_0\,e^{-p\,\iota},$$

where

$$\tan p = \tanh \alpha\,.\,\tan \beta,$$

$$\tan q = \tanh (1 - n)\,\alpha\,.\,\tan (1 - n)\,\beta.$$

If y_0 is a real harmonic of the form, $\text{A} \cos \omega\,t$, we have

$$y_n \surd (\cosh 2\,\alpha + \cos 2\,\beta) = \text{A} \surd \{\cosh 2\,(1 - n)\,\alpha + \cos 2\,(1 - n)\,\beta\} \cos (\omega\,t - p + q),$$

and

$$y_1 \surd (\cosh 2\,\alpha + \cos 2\,\beta) = \surd 2\,.\,\text{A}\,.\cos (\omega\,t - p).$$

$$\surd \frac{\cosh 2\,\alpha + \cos 2\,\beta}{2}$$

is the quantity that has been called the attenuation of the harmonic.

The equation to determine α and β takes the form,

$$\mu^2 = (\alpha + \beta\,\iota)^2$$

$$= (\text{R} + \text{L}\,\omega\,\iota)\,\{\text{K}\,\omega\,\iota + i^{-2}\,(r - l\,\omega\,\iota)\}.$$

So that

$$(\alpha^2 - \beta^2)\,i^2 = \text{R}\,r + \text{L}\,l\,\omega^2 - \text{K L}\,\omega^2\,i^2$$

$$2\,\alpha\,\beta\,i^2 = \text{K R}\,\omega\,i^2 + r\,\text{L}\,\omega - \text{R}\,l\,\omega,$$

whence

$$(\alpha^2 + \beta^2)\,i^2 = + \text{I}\,i\,\{(\text{I} - \text{K}\,l\,\omega^2)^2 + \text{K}^2\,r^2\,\omega^2\}^{\frac{1}{2}}.$$

The expression for the spuare of the attenuation, viz. :—

$$1/2\,(\cosh 2\,\alpha + \cos 2\,\beta)$$

is composed of two terms, of which the first, 1/2 cosh 2 α, is always positive and lies between ·5 and ∞. The second, 1/2 cos 2 β, is the result of resonance and may have any value between + ·5 and − ·5. In practical cases it is generally negligible, compared with the first term. For problems of telephony it may, perhaps, be neglected, if cosh 2 α is > 5, *i.e.*, if α exceeds 1·15. If in any part of the range of harmonics, important in the human voice, α is much smaller than this, say about ·5, for example, one would expect the effects of resonance to make the line useless for transmitting speech.

Section 3.—There are three special cases to consider.

Case A.—There is no leakage so that i is infinite. The differential equation is now

$$d^2\,y_n/d\,n^2 = \text{K}\,d/dt\,(\text{R} + \text{L}\,d/dt)\,y_n$$

$$2\,\alpha^2 = \text{K}\,\omega\,(\text{I} - \text{L}\,\omega)$$

$$2\,\beta^2 = \text{K}\,\omega\,(\text{I} + \text{L}\,\omega).$$

If L ω is several times larger than R, I may be written L ω + R^2/2 L ω,

then

$$2\,\alpha^2 = \text{R}^2\,\text{K}/2\,\text{L}$$

$$2\,\beta^2 = 2\,\text{K L}\,\omega.$$

If this value of α is large enough to allow cos 2 β to be neglected in comparison with cos h 2 α, the attenuation is the same for all harmonics, and the line is said to be distortionless. By making L large the attenuation is made small. Dr. Pupin has taken out a patent for the practical details of applying this principle to telephone lines by inserting highly inductive coils in series with it.

Case B.—There is non-inductive leakage to give Heaviside's distortionless circuit. Here $l = 0$, and the differential equation is $d^2\,y_n/dn^2 = (\text{R} + \text{L}\,d/dt)\,(r^{-1} + \text{K}\,d/dt)\,y_n$. If K R r = L, this becomes $d^2\,y_n/dn^2 = (\text{M} + \text{N}\,d/t)^2\,y_n$

where M^2 = R^2 K/L, and N^2 = K L.

In this case $\alpha = \text{M}$, and $\beta = \text{N}\,\omega$.

The same remarks apply to this case as to the last, about the limits within which it is distortionless.

Case C.—Inductive leakage is applied to a line whose inductance is small.

In the equations for determining α and β in the general case write L ω = m R, and $r = n\,l\,\omega$.

Then

$$\alpha^2 - \beta^2 = \frac{\text{R}}{\text{L}\,\omega}\,.\,\frac{m + n}{1 + n^2} - \text{K R}\,\omega\,m$$

$$2\,\alpha\,\beta = \frac{\text{R}}{\text{L}\,\omega}\,.\,\frac{m\,n - 1}{1 + n^2} + \text{K R}\,\omega.$$

If n is small compared with unity and with m, the equations give

$$2\,\alpha^2 = (\text{K R}\,\omega - \text{R}/l\,\omega)\,(\pm \surd 1 + m^2 - m)$$

The sign to be given to $\surd 1 + m^2$ will be + if K R ω is > R/l ω, and − if K R ω is < R/l ω, so as to make the right-hand side of the equation + ve in either case.

If m is large and K R ω is > R/l ω, as in *Case A*, the value of α is small, but becomes very large for a small change of ω, when K R ω − R/l ω changes sign and with it the sign to be given to the radicle. But if m is small as in a submarine cable, the value of α may be made small, by making K R ω − R/l ω small This is the basis of the proposal made some years ago by Prof. S. P. Thompson to improve submarine cables by inserting highly inductive leaks.

(*To be continued.*)

PARALLEL RUNNING FOR CENTRAL STATIONS.

BY L. R. LEE.

THERE is no doubt that the wish of every central station engineer is, or ought to be, to give an uninterrupted supply of electrical energy.

At the present time, and still more as time goes on, when the general public are looking upon electric lighting and electrically-driven plant as good, commercial, and business-like investments, the question of uninterrupted supply becomes daily of more importance, more especially in very large towns or districts, where it is usual to find fairly heavy day loads in the form of motors.

Most central station engineers have a very great liking for the word efficiency; but surely it would be better for everyone to lose a little in efficiency and to gain a supply which could be looked upon as certain.

There seems to be nothing more galling to an electrical man, when visiting some consumer's premises, than to be told that the gas has been left installed in case of failure of the electric light.

Now, providing that money enough has been spent and care enough has been taken in the selection of material for the first instalment of an electricity supply works, there is no reason why breakdowns should occur more often in such a works than in a gas supply works. But, sad to say, the first cost is looked at far too much, and much material is installed that will not stand the strains which it is called upon at times to stand, and, in consequence, breakdowns occur, to the discomfiture of all concerned; at the same time doing much to mar the progress of the undertaking, and to stop it thereby from being an efficient one. Thus it will be seen that when speaking of efficiency, breakdowns have to be included.

I do not mean to say that the engineer, in all cases, is to blame for niggardly expenditure; he, more often than not, is trying to please a narrow minded public by giving them something cheap. Ratepayers certainly ought to be able to see by this time that, in giving up their old systems of lighting, they are doing wisely, and ought, accordingly, to go in for something good and lasting, though they have undoubtedly

had their faith in electricity shaken by the failures which have from time to time occurred.

Owing then to the use of this material which is liable to breakdowns, it seems to me that the question of steady supply resolves itself into that of a system, in which the whole area supplied shall not be affected when such a breakdown occurs; this again seems to bring up the question of parallel running.

Parallel running can be considered under three heads, viz. :—

1. Parallel running in which both the generators supplying the network, and the network itself, are coupled in parallel.

2. Parallel running in which the generators are coupled in parallel and the network is divided into districts, each district being fed by a separate feeder or a group of feeders.

3. Running in which neither generators nor network are coupled in parallel—that is to say, the network to be as in No. 2.

Consider the possibilities of No. 1 first. As before stated, there being no reason why a breakdown should occur, granted that most excellent material and workmanship have been used, then method No. 1 is the one to employ, as it is certainly the most efficient in every way and to everyone.

There is no doubt that excellent parallel running can be got as well from alternating current generators as from continuous current generators. Speaking for awhile on the type of continuous current generator to be employed, it should in the case of a combined station—*i.e.*, for lighting and traction—be a compound wound machine, arrangements being made to cut out the series winding when in use for lighting only. The shunt winding is probably best supplied from the station bus bars. The use of a fly-wheel, though needed to secure smooth and even running, is attended with some danger, in the case of heavy faults on the outside circuit, the momentum causing currents still to be generated and finally the burning of the armature windings. If one used a fly-wheel, one would also like to use a circuit breaker on the machine, the trouble being, however, that the circuit breaker goes when not wanted to go. The weight of the fly-wheel therefore requires careful consideration.

As for alternating current generators, perhaps the best results are obtained from those in which iron forms a part of the armature. It is well known, however, that successful parallel running depends to a very large extent on the engine, more especially if the alternator be "direct driven."

The engine, then, should have a very good turning moment and governors not too sensitive; if very sensitive they are apt to cause the engines to hunt, thus causing a rapid interchange of synchronising current, which results in that irritating flicker one often sees in alternating lighting with incandescent lamps.

This flickering is more noticeable when the combined engine and alternator are connected by a flexible coupling, such a coupling causing another oscillation of the load so driven. Such couplings, however, are apparently not much in use, and certainly cannot be recommended, if for no other reason than that mentioned.

The exciters should be separately driven, and are best used in conjunction with a battery of secondary cells; that is to say, this is best for efficient running and for general manipulation.

Before leaving the subject of engines, there is no doubt that all the engines used in a station, if they are intended to be used for parallel work, ought to be of the same type—especially in the case of alternating currents, and if the most efficient running is desired, though not affecting the question of parallel working, I would go so far as to say that all plant, whether engines, boilers, or generators, ought to be, in each case, of the same type.

There have been cases in which turbines have been tried for parallel running with engines when coupled to alternators. There is no need to say that the trials have not usually produced satisfactory results.

I am reminded of a case here which came under my notice some years ago, in which, although parallel electrical running was not called into question, it certainly did have a bearing on the questions of type and turning moment. I was sent by the firm with whom I was then engaged to look into the complaint made by a mill owner to whom they had supplied one of their engines, fitted with a patent governing expansion valve. The mill owner complained most strongly that the patent gear was of no use whatever, and had asked that it might be removed and an ordinary gear substituted. I was shown into the engine room, and noticing that the crankshaft of the engine was passed through a wall, I asked what was coupled to it on the other side? "Oh," said the driver, "the water-wheel is coupled on there." And actually the sensitive expansion valve was expected to give good results under these conditions, with a water-wheel coupled on the same shaft. This is by the way; no central station engineer would, of course, attempt such a thing.

Further consideration of No. 1 brings us to the network. The cables of the network, if coupled in parallel, certainly give the most efficient results, as the E.M.F. is maintained more constant thereby; and although the network be so coupled, that is to say, interconnected sub-station with sub-station by the use of sub-feeders, still it is very easy to design a network in which the cables are connected at their ends to switches or quick disconnecting gear, so that at any time the network can be sub-divided in a few minutes into several separate networks.

Again mentioning the use of the excellent material before referred to, I believe that it is quite possible, nay, fairly simple, to put down a network that shall not be troubled with faults, either through the cables going wrong or through external damage.

In considering method No. 2 nothing more need be said concerning the generation, as the same remarks apply.

One subject here demands, perhaps, more attention than in No. 1. This is the design of the feeder switchboard. It may be remarked that the network under No. 2 conditions is in parallel, as much as when under No. 1; this is not so. In No. 1 the central station staff cannot control the network as they can in No. 2, as in this case they can, in the event of a breakdown, which will easily be located by the feeder ammeters, immediately switch off the offending district. Hence the necessity for special attention to the design of the feeder switchboard, it being absolutely necessary that each feeder should be provided with an ammeter, and should be, of course, on a separate switch and fuse.

I would, however, as in the case of No. 1 network, still lay interconnecting feeders, but only keep them charged at one end, thus not putting them into actual work.

It is quite necessary to keep such cables charged, so as to be able to see what is taking place on the network. If such cables were left disconnected for some length of time, on wishing to put them into use again, they might show a fault, which would hinder their being used until the fault was located and the cables repaired; whereas, supposing the cables had been charged at one end, the fault would have been noticed and repaired, and the cables would be ready for use as soon as required.

Consideration of No. 3 will show that even more attention has, in this case, to be paid to the design of the central station switchboard or boards.

This most inefficient way of supply would mean that each generator had as many switches as there were feeders, and that each feeder had as many switches as there were generators. This would be required to allow of any generator being switched on to any feeder, so that it would be necessary at times to parallel two machines. This would also be necessary were it proposed to run in parallel at the time of light load, and to run separately as soon as enough load came on to divide between the machines.

The network under No. 3 remains in design as in No. 2.

Street-lighting cables I should always in any case run separately from the private lighting network, feeding them by separate feeders direct from the station switchboard.

Providing, then, that the very best materials and workmanship have been employed, No. 1 method may be used and a satisfactory supply given under the conditions which generally obtain. However, No. 2 seems to be the ideal method as far as efficiency is concerned; though No. 3 would most likely be the best method to use—that is, parallel running through light load and separate running in heavy load, providing that ordinary

work was put down and that cheapness had been indulged in—if one could only bring oneself to look at a switchboard design such as would be entailed. Engineers who have been used to high tension working would at once grasp what such a design would be like, though for a low tension supply such a board could be easily designed and made. Insulation, and protection to the users of the switches, would play a part of the first importance in the design of such a board for use with high tension currents.

FAULT FINDING ON TRAMWAY SYSTEMS.

BY A. JOHNSTON.

IN electric lighting systems the most troublesome item is the mains, which cause the engineer in charge of them a great amount of anxiety, and he is all alive to the fact that he must have some quick method for finding a fault when one develops, so some provision is usually made in the laying of the cables to assist him.

Why should a tramway system be neglected in this respect? It has its mains like the lighting system, and its overhead wires, which are more liable to fault than underground mains, chiefly on account of the "matter of form" guard wires, and a method for locating the fault from the

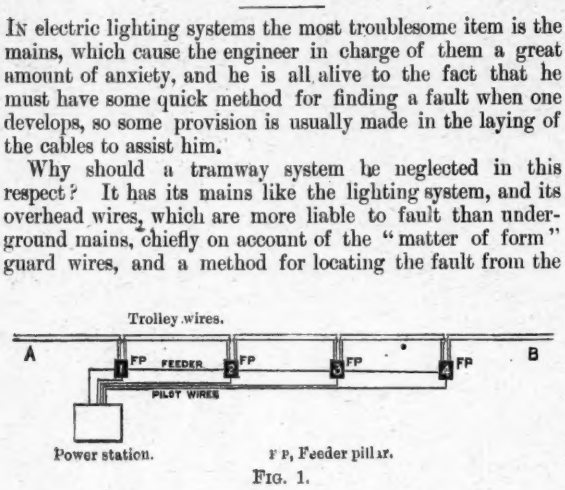
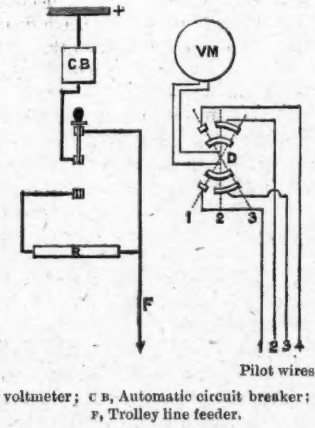


FIG. 1.

station would be a great advantage, more especially in long lines with the supply station near one end of them. A good system to obtain this end is shown in figs. 1 and 2. Fig. 1 shows a short tramway 2½ miles in length, with the feeder, trolley wire, and pilot wires for testing which go from the



V M, Testing voltmeter; C B, Automatic circuit breaker; R, Resistance F, Trolley line feeder.

FIG. 2.

supply station to the bus bars in the feeder pillars. In the supply station they go to a small double-pole multiple-way switch, to which is also connected a low-reading voltmeter as shown in fig. 2.

The test is as follows:—Suppose a short circuit has developed. Change the throw-over switch (fig. 2) to down position, which will allow a limited amount of current to flow through the feeder, this current being controlled by the resistance that has been put in series with it; then put the testing switch D (fig. 2) in the position marked 1; by so doing you connect up the low-reading voltmeter between the pilot wires 1 and 2; in other words you take the drop in volts between the feeder pillars. If you get the correct drop, which can be found by calculation or experiment (a record of which should be kept always at hand) the fault is at or further away from the supply station than feeder pillar No. 2. A similar test can be made between the other feeder pillars, and by that means the fault located, but another position should be shown on the switch D, fig. 2, to enable the voltmeter to be put across between the positive bus bar and feeder pillar No. 1, in case the feeder should break down between those two points. If this should occur, the position of the fault can be found, as the total drop on this length is known, which we will call V_1; then if the drop found by the test when the fault is on, is V_2, the distance of the fault from the supply station will clearly be

$$\frac{V_2 L}{V_1},$$

where L is the total length of the cable under test. A fault often occurs which is not a "dead" short circuit, that is, it has in itself a certain amount of resistance to earth which may cut down the current below the standard amount allowed by the auxiliary resistance, and from which amount the calculations have been made; this, however, will introduce no error; for suppose the fault was on the feeder between the supply station and feeder pillar No. 1, as in the last case, the position of the fault will be

$$\frac{C_1 V_2 L}{C_2 V_1},$$

where C_1 is the standard current, and C_2 the current going through the cable during test.

It will be seen that the most important section of the feeder is that between the supply station and the first feeder pillar upon which the whole section depends for current, and the need for immediate location and repair of any fault is therefore self-evident.

Cars on the line may be disregarded when the fault is a "dead" short, as the potential difference between the trolley wires and the rails will be very small, probably under a volt; when this voltage increases the cars can be allowed for with a little practice, but may as a rule be disregarded.

The example taken as fig. 1 is a simple straight line, but a complicated tramway system will not introduce much extra difficulty if each feeder has a separate switch for testing like D, fig. 2, which would be best placed on its own panel on the switchboard.

CORRESPONDENCE.

Tests of Electric Hoists.

The account of the tests of two electric lifts, published in your issue of yesterday, is of considerable interest, and should be instructive to many prospective users, if only as to what to avoid.

But it would be most unfortunate if any of your readers were left under the impression that the machines described and tested have more than the most distant relationship to a properly designed electric lift, as turned out by firms making a speciality of the business.

The results obtained nowhere exceeded a mechanical efficiency of 39 per cent., and this only in one particular test. It may be mentioned here that efficiencies of 75 per cent. to 80 per cent., when lifting maximum loads, are easily attainable from the lift itself apart from the motor, if they were desirable; but they are not. In a machine such as a lift, where the results of an accident are so serious, and where by reason of intermittent action the cost of power can never be great, it is usually preferred to sacrifice some efficiency to safety, and the principle usually adopted is that the efficiency shall be kept below 50 per cent., so that should the brake gear absolutely fail, the load cannot take charge and run the machine backwards. In other words, the friction is always to be greater than the net work, so that should the "work" or load endeavour to become the motive power, the friction alone will be sufficient to overcome that endeavour, and hold the machine.

In practice a mechanical efficiency from 40 per cent. to 45 per cent. is usually aimed at and attained.

The first great mistake in the lifts reported on, was to drive them by belting from a motor constantly running;

they should have been directly coupled. The next, and a very serious one, was the omission to balance a large proportion of the load. The author of the report also indicates some inferior workmanship.

We have made a large number of similar tests of our own lifts, which have been collected and averaged for office use, and from these results we have taken some figures showing the power which would be consumed by a properly designed direct-coupled and balanced machine, doing the same work as the smaller machine reported on. These figures we append in tabulated form, side by side with the results quoted in your report, for the purpose of ready comparison.

We assume for our machine a total efficiency on maximum load equal to 40 per cent., this being well within the mark.*

We also assume that the load will be half balanced; and noting that the tested machine when lifting 20 cwt. only travelled at 36 feet per minute, we adopt that speed throughout the table, and have proportionately reduced the reported consumption of the tested lift, where this relates to speeds greater than 36 feet.

It will be noted and perhaps objected that the direct-coupled lift when lowering full load, or raising empty cages, is only debited with 220 watts, or one ampere. This is, however, amply confirmed by numerous tests, the explanation being that one of these machines, once started under the conditions named, will continue the journey at a slow pace without any current whatever, and one ampere usually suffices to hurry it up to its proper speed.

Work done at 36 feet per minute throughout.	Power consumed.					
	Belt lift with load unbalanced.			Direct-coupled lift with load half-balanced.		
	Watts.	Average for round trip.	General average.	Watts.	Average for round trip.	General average.
Hoisting empty cage	2,442	2,442	3,179	220	1,255	1,193
Lowering „	2,442			2,290		
Hoisting 11¼ cwt. ...	4,883	3,450		1,180	1,070	
Lowering „ ...	2,017			960		
Hoisting 20 cwt. ...	5,525	3,645		2,290	1,255	
Lowering „ ...	1,765			220		

A comparison of results shows at every point an enormous advantage in favour of the direct-coupled machine. This is particularly noticeable in the case of lowering full load; it might have been expected that the belt machine being entirely unbalanced, would have required some restraint upon its descent, instead of which it actually consumed 1,765 watts in being pulled down.

Comparing round trips, the empty cage of the belt machine consumed about double the power required by the direct; a load of 11¼ cwt., or of 20 cwt. each required about three times the power in the belt machine.

The general average for all classes of work comes out at 2⅔ to 1 in favour of the direct-coupled lift.

But the losses do not end there. The table deals only with current consumed when the cage is moving, and in the direct-coupled machine no other current is required. But in the belt machine the motor, belts, and second motion shaft were running during the whole time the cage was standing at any floor, and all the time consuming 1,100 watts.

Let us see what this actually means in practice. The lift took two minutes for the travelling time of a round trip; being a goods lift the cage could not be loaded and unloaded under five minutes. For an average working round trip we get then 3,179 watts for two minutes = 6,358 watt-minutes plus 1,100 watts for five minutes = 5,500 watt-minutes or a total of 11,858 watt-minutes. On the other hand, the direct machine required only 1,193 watts for two minutes = 2,386 watt-minutes, say one-fifth only of the energy required by the belt machine.

One modification of this result is, however, necessary, inasmuch as the direct machine will demand additional current each time of starting, but even adding this it will come out an easy winner at 4 to 1.

Your contributor at the conclusion of his report advocates spending money on very slow-running motors instead of on speed-reducing gear, and for very low speeds of cage, such as those considered, he is no doubt right. But if he were confronted with the more usual problem of constructing a lift to run at 200 feet to 250 feet per minute, which must have somewhere in its gearing a worm and wheel designed not to drive backwards, he would probably find himself compelled to retain a moderately high speed motor.

Arch. Smith & Stevens.

* This is calculated at 746 watts to the horse-power, and therefore includes the efficiency of the motor.

Underground Railway Systems.

The derangement of carriage brake-gear on one of the trains which on 28th ult. entailed a temporary suspension of the entire traffic on the Central London Railway (with which I was formerly connected) would in all probability not have had a like effect on a "third-line railway," the design of which locates the steel conductor at the side of instead of between the other two metals.

Such construction was adopted on our pioneer—Portrush-Giant's Causeway—tramroad in 1883, and subsequently on the Chicago South Side Elevated Railway, and on the Nantasket Beach Railway in 1896.

This style of equipment has been recently revived on the Buda-Pesth Subterranean Railway, in 1896, and only completed this year on all four of the Paris electric railway systems. The latter comprise :—

1. The Metropolitain, which corresponds to our C.L.R., traversing the city between the Bois de Boulogne in the north-west, Bois de Vincennes in the south-east, *viâ* the Place de l'Etoile (containing the famous Arc de Triomphe), whence two branches radiate. An excellent illustrated description hereof appeared in the Electrical Review of August 24th, 1900, and also in the October 11th issue of the *Tramway and Railway World.*

2. The Chemin de Fer de l'Ouest extension from the Gare des Invalides to the station at the Champ de Mars, adjoining the Eiffel Tower.

3. The city electrical extension of the Chemin de Fer d'Orleans from the old Quai d'Austerlitz terminus to the superb new terminal in the Quai d'Orsay.

4. The Exposition Uni-directional Railway.

(*a*) Paragraphs 1, 2 and 3 are subterranean, just beneath the street surface.

(*b*) Paragraph 2 is the partially completed scheme for an electric line from opposite the Place de la Concorde, in the heart of the City of Paris, along the left bank ("Rive Gauche") of the Seine, to the outlying suburbs of Les Moulineaux—which possesses the largest electric installation in France—St. Cloud and Versailles. A steam connection links the Eiffel Tower station with the Gare St. Lazare, across the river, but I believe electricity is to supplant this power shortly. It is the Western Railway of France which is owned by the State.

(3) Is occasionally in open cutting, and, near its terminus, is divided from the Seine by an embankment wall, pierced with windows at short intervals.

Good photos. of this and of locomotives employed appear in the *Tramway and Railway World*, November 8th's issue.

(4) Was, of course, only temporary, and paralleled the contra-running "moving platform." It was therefore built as a single-track railway.

The actual arrangement adopted in the cases of (1), (2) and (3), consisting of double-track lines, is to place the "third rails" between the up and down lines, at a slightly higher level.

On (1)—the "Metropolitain"—these "live" rails were *left unprotected*, but *painted red* for the length of the station platforms, and "danger" notice boards were affixed to the walls by the latter.

On (2) and (3)—the main line railways—the live conductor rails are *boxed in* by stout planks, to prevent accidental contact of permanent way operatives, and contact is established with the locomotive's collector or "plough" through a horizontal slot in the side of the casing, just

beneath the top cover. Such an arrangement would *enable passengers to walk with impunity through our London "tubes"* when traffic is suspended.

5. Finally, the London Metropolitan District Railway, which ceased its experimental runs a month since, may be cited as a "side-rail" construction. Here, as Londoners know, + and — rails were disposed on either side of the ordinary metals for each "road."

It will also be remembered that in December 21st's issue of the ELECTRICAL REVIEW a newly converted Berlin electric railway was referred to as possessing a "side third rail."

I have introduced this matter in the hope of the *pros* and *cons* for each type being elicited, and the balance of advantage arrived at by discussion. Of course, in 11 feet 6 inches circular "tubes," not too much room is available at rail level, 1 foot 7 inches above lowest point of invert, for unnecessary fittings *at the side* of the track, when such may be accommodated in the centre.

Edgar L. Benjamin.

London, *December 29th*, 1900.

Blast Furnace Gas Power Installation.

We have only just seen your issue of the 14th inst. containing the article with the above title. We think it is only fair that the persons who had the responsibility of the designing and making of the 100-H.P. gas engine should have their names mentioned in connection with this matter. The wording of the paragraphs connected with the gas engine is so vague, that unless anyone read them with great care, they would think that the engine had been designed and manufactured by the Blast Furnace Power Syndicate. This was our own impression until we read it over once or twice. We should like, however, to state that the engine in question was designed and made by a member of our staff, namely, Mr. Hartley, of the late firm of Messrs. Hartley & Petyt, engineers, of Bingley, and we think a good portion of the credit for the successful working of the plant in question is due to the gas engine.

pp. **The Campbell Gas Engine Company, Limited,**
HUGH CAMPBELL.

Halifax, *December 31st*, 1900.

[According to our information, the engine referred to by our correspondents was supplied to the Sheepbridge Iron Works by the Blast Furnace Power Syndicate, and the special patented features referred to in our article are the property of the syndicate. Messrs. Hartley & Petyt, apparently, were sub-contractors to the syndicate. We fail to appreciate the *locus standi* of the Campbell Gas Engine Company in the matter; they are unaffected either way.—EDS. ELEC. REV.]

Nernst Electric Lamp.

May I, as one possessing some knowledge of the facts in this matter, supplement your article in last week's issue by the following observations:—

You rightly point out that the Nernst Electric Lamp Company was formed, and the patents sold to the public, before the lamp had passed out of the developmental stage into a commercial form. This in itself is unobjectionable, provided the public were notified that such was the case in the prospectus upon which capital was subscribed.

It is clear, however, from what passed at the company's recent general meeting, that a section of the shareholders embarked their capital in the company under the impression that the Nernst invention was already ripe for commercial usage, and their disappointment at the absence of dividends, and the heavy fall in the market value of the company's shares, found vent in charges against the board and staff of apathy and mismanagement.

This contention is not borne out by the facts. Anyone acquainted with the inevitable delays involved in transforming an experimental piece of apparatus, as the Nernst lamp was in 1898, into a commercial article, as the lamp is now in process of becoming, will hold, on a careful examination of the latter, that good work has been done in the interval since the formation of the company.

This view is confirmed by the circumstance that companies possessing such resources as the Westinghouse, the Allgemeine and Messrs. Ganz & Co., who have been at work on the Nernst lamp in America, Germany, and Austria respectively for a longer period than the Nernst Company in England, have nevertheless failed to achieve commercial results superior to the latter.

But shareholders are not generally technical experts; and in searching for a ready explanation of their misfortunes they not uncommonly, as in this instance, endeavour to trace them to the shortcomings of their stewards rather than to their own lack of discretion or understanding as investors. Hence the extravagant charges levelled against the administration and staff of the company—charges to which no one acquainted with the individuals concerned, and the results they have achieved, will give credence.

Whether it is wise to replace the men who have carried the matter thus far, by others who would necessarily be ignorant of the difficulties encountered and overcome, is a question for the shareholders. I venture to suggest that the policy may prove one of suicide.

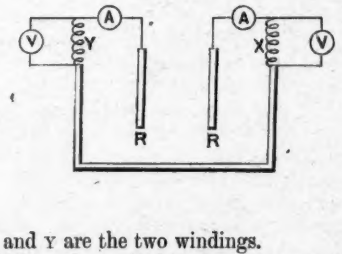
It is not necessary to dwell on this, as doubtless the board and executive will be able to refute the fanciful charges advanced against them. My object is to confirm the impression given by your article that material progress has been made towards the end, which all electrical engineers will welcome, of placing the Nernst invention on the market in a cheap, practical and reliable form.

R. P. S.

London, *December 31st*, 1900.

A Two-Phase Problem.

Some time ago I witnessed the efficiency tests of some two-phase steam alternators, in which an ordinary water resistance, consisting of an iron tank with two rods immersed, was used. The "inners" of the two windings were connected to the two rods, and the "outers" to the tank. The output of the machine was calculated by adding the products of the amperes and volts, as shown on the instruments, which were connected thus—



—where X and Y are the two windings.

I should like to know if this was correct, as it occurred to me that besides the currents flowing from the rods to the tank there would be a current flowing from one rod to the other and through the two windings and tank in series, in which case it would be at a greater voltage than that shown on the two voltmeters, and would, moreover, flow through the two ammeters in series, the voltage between the two rods being $\sqrt{2}\,v$, where v is the voltage of each of the windings.

The efficiencies found at these tests were high, which I think was possibly due to the above method of testing.

Seloc.

Information Wanted.

Could you or any of your readers kindly give me the following information:—

What action is performed in the deposition of metallic-chromes with a solution of acetate of lead, in which the article on which the chromes are to be deposited is composed of

steel and in connection with the *anode*, the negative electrode being *copper*.

J. H. Anderton.

P.S.—I am aware that superoxide is formed and is responsible for the chromes, but how is this action performed?

THE VICARINO SYSTEM OF TRAIN LIGHTING.

WHETHER or not the problem of train lighting has been satisfactorily solved is perhaps an open question, but if the results claimed for the Vicarino system can be borne out in practice, it is certain that at least one other satisfactory system will have been added to those already tried.

There can be no doubt that, in principle, the electric light has many advantages over gas or oil. The questions of first cost and cost of maintenance, however, weigh more in the balance with railway directors than such incidental advantages as passengers' comfort, and this is not unreasonable, since a railway company is formed for the purposes of transporting—*inter alia*—passengers from one point to another, and the contract ends when the passenger has been duly transported. A story is told of a director of a certain railway company who drummed for some minutes at the pigeon hole of a booking office before the clerk condescended to approach him and ask what he was waiting for. The director's reply was more forcible than polite, but when translated into parliamentary language ran somewhat to the effect that he was "waiting" to let the clerk know that he was a director of the line, and that the clerk would subsequently find out what that meant. "Good heavens" begged the clerk "you must forgive me, sir,—I thought you were only a passenger."

From the manner in which trains are usually lighted it may reasonably be inferred that the same principle obtains on most railways.

Assuming, however, that electricity is one of the best, if not the best, ways of lighting a train, it is clear that the system adopted should be based upon the following fundamental principles.

1. Apparatus employed should be simple and not liable to get out of order.
2. Weight should be as small as possible.
3. First cost of installation should be small.
4. Cost of production and maintenance should be at least as small as that of gas or oil.
5. Carriages should be capable of being run on other companies' lines.

Condition (5) is an important one, as the through traffic of a railway may reach a high percentage of its total traffic. This condition is manifestly complied with by an installation of accumulators on each carriage. Accumulator lighting, however, involves a charging station, and as it would not be easy to arrange for each carriage to carry a sufficient storage to enable it to return to its starting point before requiring a fresh charge, it would be necessary to erect charging stations along the line. This not only means expense, but delay, and this is a serious question on a railway.

Without entering into an inquiry as to the relative merits of the various systems of lighting trains by electricity, which, moreover, are probably well-known to most of our readers, it may be well to consider shortly the salient features of the Vicarino system, which in its leading characteristics resembles the Stone system.

Mr. C. Vicarino uses an axle driven dynamo fitted with an ingenious arrangement of brush-holders, whereby the direction of motion of the carriage is rendered immaterial. This dynamo supplies light to the carriage lamps in connection with a small battery of accumulators. An auxiliary apparatus cuts the accumulator in and out at the proper moment, and is also arranged to equalise the voltage so that the pressure at the lamps does not vary very much.

The dynamo, moreover, is compound wound, the series winding being arranged to oppose the effect produced by the shunt winding.

The general principle upon which the whole arrangement is intended to work is that at the normal speed of the train the dynamo is driving the lamps direct. At lower speeds the accumulator runs the lamps, and at higher speeds the surplus current generated by the dynamo over and above that necessary for the lamps, goes to charge the accumulator.

The following figures are given by the Compagnie Générale Electrique, of Nancy, as the results of tests made with the Vicarino apparatus, which, in this particular instance, was adjusted for a mean speed of 50 kilometres per hour. Obviously, it could be adjusted for any other speed.

COST OF PRODUCTION PER LAMP-HOUR OF 10 C.P.

Renewal of lamps ... ... [Cost of lamp assumed to be 80 centimes, and life 800 hours, on the average.]	0·1 centime.
Maintenance of positive plates ... ... [The battery has a capacity of 40 ampere-hours and contains 60 kilogrammes of positive plates at 1 franc 50 centimes per kilogramme.]	0·2 „
Acidulated water, oil, waste, &c.	0·03 centime.
Motive power ... ... [The power absorbed by each carriage is 0·5 H.P., equal to 1 kilogramme of coal per hour at 2 francs per 100 kilogrammes.]	0·25 „
	0·58 centime.

Or say 0·6 centime per 10 C.P. lamp-hour.

In comparison with this the company cite the following figures, which, it is stated, have been gathered from the results of other systems of lighting:—

Oil per lamp-hour, 5 or 6 candles	4·5 centimes.
Compressed oil-gas per lamp-hour, 10 candles	3·5 „
Accumulator lighting per lamp-hour, 10 candles	3·4 „
Acetylene per lamp-hour, 10 candles ...	2·5 „

The first cost of installation for the various systems is given as follows:—

Oil	about 200 fr. per carriage.
Gas ... ... [Without regard to proportion per carriage of cost of erection of gas plant at station.]	„ 800 fr. „ „
Accumulators (8 lamps of 10-C.P. and battery of capacity of 120 ampere-hours)	950 fr. per carriage.
Vicarino system (8 lamps of 10-C.P. and battery of 40 ampere-hours capacity)	1,250 fr. „ „

The cost per annum of the various systems, assuming the carriage to be lighted on the average 4 hours per day, is stated to be as follows:—

Oil (4 lamps of 5-C.P. = 20-C.P.)	262 fr. 80 c.
Gas (4 lamps of 10-C.P. = 40-C.P.)	204 fr. 40 c.
Accumulators (8 lamps of 10-C.P. = 80-C.P.	292 fr. —
Vicarino (8 lamps of 10-C.P. = 80-C.P. ...	70 fr. —

The company further draw attention to the applicability of their Vicarino dynamo for the generation of electrical energy from a variable source of power such as a windmill, or turbines driven by streams, the volume of water in which depends upon the rainfall.

BUSINESS NOTES.

Electrical Wares Exported.

WEEK ENDING JAN. 2ND, 1900.		WEEK ENDING JAN. 1ST, 1901.	
Alexandria	Value £50	Beira	Value £320
Amsterdam	20	Buenos Ayres. Teleg. mat. ..	133
Bangkok	1,920	Calcutta	900
Bombay	27	Cape Town	246
Boulogne	88	Channel Islands	699
Brisbane	130	Christchurch	30
„ Teleph stores ..	170	Colombo	10
Calcutta	434	Copenhagen. Teleg. wire ..	238
Cape Town	541	Flushing	20
Christiania. Teleg. cable ..	534	Ghent	19
„ Teleph. cable ..	392	Gothenburg. Teleg. wire ..	13
Colombo	31	Hamburg. Teleg. mat. ..	500
Durban	304	Madras	20
„ Teleg appar.	974	Melbourne	115
Fremantle. Teleg. cable ..	3,795	Rosario	456
Gibraltar	61	Valparaiso. Teleg. mat. ..	523
Gothenburg. Teleg. wire ..	39	Zanzibar	88
Hamburg	14		
Hong Kong	£90		
„ Teleg. cable ..	830		
Lisbon	83		
Melbourne	343		
Montreal	47		
Ostend	156		
Passages	24		
Rotterdam. Elec. light machy.	1,462		
St. Petersburg	75		
Singapore	44		
Stockholm Teleg. mat. ..	180		
Sydney	770		
Total ..	£13,'98	Total ..	£4,328

Foreign Goods Transhipped.

Barbadoes. Teleph. appar.	Value £21	Brisbane. Teleph. mat.	Value £100
Brisbane „ „ ..	120		
Total	£141		

Arbitration.—The award in the arbitration between the Chloride Electrical Storage Syndicate, Limited, and the Corporation of King's Lynn, which was heard on December 4th last before Major Philip Cardew, R.E., has now been made. The arbitrator has ordered the Corporation to pay the sum of £100, and the costs of the syndicate and of the arbitrator. The amount claimed by the syndicate was £301 1s. 7d., the principal part of which represented labour expended in erecting the storage batteries at the electric lighting station of the Corporation, it being claimed by the syndicate that they were entitled to charge for all labour under the "day work" scale in the schedule of quantities, in addition to the prices quoted for material; the contention of the Corporation was that such prices included all necessary

labour. The arbitrator was appointed by the president of the Institution of Civil Engineers on the application of the Syndicate, the Corporation appearing at the hearing under protest on the ground that the matter was not one within the jurisdiction of the arbitrator, but one on which the decision of their engineer was intended by the contract, to be final.

Annual Dinner. — The Sunderland Forge and Engineering Company has decided to hold annual staff dinners, and the first of these was held at Sunderland on December 28th.

Auction Sales.—On Tuesday next and following days Messrs. Bennett & Son will offer for sale by auction at Dublin a large assortment of electrical fittings and electro-medical appliances, also gas engines and dynamo. The sale is being made by order of the liquidator of Dobson & Curtis Bros., Limited. Further particulars will be found among our advertisements to-day.

The Nelson Corporation is offering an E.P.S. central station K-type battery for sale. Messrs. Wheatley Kirk, Price & Co., will shortly sell by auction, the works premises known as Haunch of Venison Yard, Brook Street, W., together with certain surplus stock of electrical fittings, cables, &c. See our advertisement pages to-day.

Books Received.—"Papers and Reports relating to Minerals and Mining." Wellington, N.Z.; by authority, John Mackay, 1900.

British Fire Prevention Committee.—Pending the opening of its new testing station, the British Fire Prevention Committee will issue reports on tests undertaken in the past year with Mural and Decorations' Company's floor, the "Cunnah-Wright" partition, the Williams' fire-blind, with two iron doors and two pairs of wood doors. Summaries regarding tests undertaken at the North Bank testing station are also in preparation. Regarding the Committee's new testing station at Westbourne Park, a sub-committee of the executive will have charge of the arrangements, Mr. Ellis Marsland presiding.

Catalogues, Lists, and Calendars.—Messrs. Nalder Bros. & Thompson, Limited, send us one of their hanging wall monthly sheet calendars for the new year.

The Anglian Engineering Company, Limited, of Stowmarket, sends us a copy of its pamphlet No. 1, in which is given an illustrated account of the "Bull" electric motors for power transmission.

Messrs. Doulton & Co. are circularising the trade to the effect that they are revising prices for earthenware goods and packages from January 1st.

The Electrical Power Storage Company, Limited, have, according to their usual custom, sent a blotting pad and diary for the year 1901 to each of their customers. Should any have been accidentally omitted the mistake will be rectified on receipt of a postcard. We also have received one of these useful desk companions.

No. 82 of the B.T.H. Co.'s illustrated pamphlets describes the Sheffield electric tramways system, in connection with which a good deal of B.T.H. plant and overhead construction has been supplied.

The Electrical Company's price list No. 8, just issued, gives details of various switches, wall sockets, and connecting plugs. Diagrams of connections for Royal switches are shown.

Messrs. Cole, Marchent & Morley, Limited, of Bradford, have issued a most effective wall card, the central feature of which is an excellent view of one of their 800 KW. standard low speed coupled compound Corliss engines for electric traction.

The British Electric Works Company send us the first 48 pages of their catalogue, which describes their various electric light accessories, which are pretty well familiar to most of our readers. There are several new departures shown, one of these being the "Stellite" distributing system, which has been provisionally protected. The several parts of the system are illustrated, including single-pole fuse and switch segments, double-pole switches and fuses, wood blocks, &c. The system is claimed to possess undeniable advantages for high voltage supply, the facility for building up boards being also a strong feature.

The Brush Electrical Engineering Company sends us, as usual, one of its very neat and convenient pocket memoranda books, which are always acceptable.

Messrs. D. Stewart & Co., Limited, of Glasgow, have issued a wall calendar, upon which appear illustrations of their erecting shop.

Concerts.—The fourth annual smoking concert of the Chelsea Electric Supply Company's Cricket Club was held on the 21st ult., Mr. Percy Still presiding, and was in every way a success.

The employés of the Hull Electric Lighting Committee assembled at the Imperial Hotel on Thursday evening last week, under the genial presidency of the chairman of the Committee (Councillor Skinner). After an excellent tea, an enjoyable musical programme was gone through, interspersed with genial speeches. The meeting was most successful throughout.

Flood.—Serious floods occurred at Loughborough early in the week, and the works of the Brush Electrical Engineering Company were among the sufferers. It is stated in an evening paper that the damage caused at the Falcon Works was so serious, as to compel 1,500 men to leave.

Hull.—Mr. J. Newton Stephens, the Peterborough district engineer to the National Electric Wiring Company, Limited, has obtained the contract for the electric lighting of the new premises now being built for the Ocean Accident and Guarantee Corporation, Limited. The installation will consist of 200 lamps, the conduit system being adopted. Mr. Stephens is also carrying out other large contracts in Peterborough and the Eastern Counties.

Liquidations and Dissolutions.—The West Kent Electricity Supply Company is winding up voluntarily with Mr. A. E. Jones, of 3, Lothbury, E.C., as liquidator.

Messrs. J. D. F. Andrews & Co., Limited, are winding up voluntarily, with Mr. W. H. King, of 13-14, Basinghall Street, E.C., as liquidator.

Messrs. H. G. Massingham and C. Lopdell (Massingham, Lopdell and Co., electrical engineers, Victoria Parade, Torquay) have dissolved partnership; Mr. Massingham will attend to debts.

A meeting of Messrs. Julius Sax & Co., Limited, is to be held at 2, Threadneedle Street, E.C., on February 1st, to hear an account of the winding up from the liquidator, Mr. C. Kuck.

New Cable Works in France.—Large new works for the manufacture of rolled wire and cables have just been completed and put in operation at Givet (Ardennes) by La Compagnie Française des Métaux.

Public Apology.—It is interesting to see, by an announcement in our present issue, that a firm of the standing of Messrs. Hands, Limited, feel it incumbent upon them to apologise to "customers, friends, and the trade generally" for not having hitherto appeared before them in the trade journals. Their example can be commended to others who may have been similarly failing in their duty in this respect to their "customers, friends and the trade generally."

Reduction of Capital.—On January 16th the petition of the Electricity Supply Company, of Spain, for the reduction of capital from £100,000 to £5,000 will be heard at the Law Courts.

Trade Announcements.—The Sun Electrical Company, Limited, have been appointed sole agents for the United Kingdom and Colonies of the Compagnie Générale Electrique, of Nancy, France. The Sun Company will shortly be holding a large stock of standard size motors, and will publish a list of them. They will be prepared to supply motors and dynamos (both for continuous and alternating current), transformers, arc lamps, combined lighting sets, and railway lighting sets. The last mentioned are a speciality of the C.G.E.

We are asked to state that the business which has been carried on for the past 11 years at 36, Dale Street, Liverpool, by Mr. Lester Taylor and Mr. Archie Kelly, will in future be continued by them in partnership with Mr. Walter J. Hide, and under the style of Lester Taylor, Kelly & Hide.

Messrs. R. W. Blackwell & Co., Limited, have just opened a branch at 7, St. Mary Street, Cardiff. The local management has been entrusted to Mr. B. Phillips-Smith, who has until lately been in charge of one of the principal departments at the head office in London.

ELECTRIC LIGHT AND POWER NOTES.

Ayr.—On Sunday night last week at 8 o'clock practically all the lights on the south side of the river were extinguished. The fault was due to water (owing to the recent storm) getting into the main cable trench at the works from the outside street piping, causing a breakdown in one of the main cables leading to the switchboard. Within two hours the fault was made good and all the lights turned on.

The C.C. has resolved to oppose the scheme of the Caledonian Electric Power Company.

Belfast.—At the meeting of the Gas and Electric Committee last week the electrical engineer (Mr. V. A. H. M'Cowen) submitted the following statement relative to the electrical undertaking during the last 12 months:—On December 31st, 1899, we had an equivalent of 51,500 8-C.P. lamps connected to the mains; we have now 73,500 8-C.P. lamps connected, or an increase of 22,000 lamps—43 per cent.—and we have applications for a further 10,000 8-C.P. lamps. The output for the year 1899 was 622,500 units sold. I estimate the output for the year 1900 at 875,000 units, or an increase of 40 per cent. The average price obtained for current supplied during 1899 was 4·36d. per unit. Owing to the reduction in price introduced in the beginning of this year, the average price will work out at about 3¾d. per unit. The Free Wiring Company has obtained for us during the year a connection of over 2,000 8-C.P. lamps. We have now about 120 electric motors, aggregating 450 H.P., connected to our mains, and applications for a further 160 H.P. The system of letting out motors on hire is being appreciated by small users of power, and we have about 150 installed, driving various types of machinery. The average price obtained for current supplied for motors during the year works out at about 2¼d. per unit, while several long-hour consumers obtained it as low as 1·6d. per unit. Notwithstanding the greatly increased cost of coal during the year, our cost of production will actually be reduced owing to other economies being introduced and to the increased output. The maximum load on the station for 1899 was 955 kilowatts, and for 1900 1,307 kilowatts, or an increase of 37 per cent. Mr. M'Cowen is in the happy position of having designed his own station and carried it through to a successful issue—though we have not heard that he received a percentage on the cost of the work from his grateful Town Council. A consulting engineer would, no doubt, have charged a fee of £2,500 for doing the same work.

Bolton.—The changes which the Corporation electricity department has undergone of late in its staffing may be regarded as completed by the appointment just made of Mr. W. J. Wood, of Edinboro', to the position of assistant electrical engineer. Mr. Wood's salary will be £110 per annum, with an increase of £20 during the next two years. The annual returns just issued in connection with the department contain the following statistical information:—Cost of works, £117,589; quantity of energy sold per annum, 842,792 B.T. units; greatest output on one day for lighting, 6,057 units, and for trams, 3,970 units; length of cables laid, 61,500 yards; number of 8-C.P. lamps connected, 56,705; total income, £12,098; number of customers, 751. Tramways:—Ten routes of over 24 miles. Capital expenditure on lines, £124,246; number of car miles run during six months ending September 30th, 683,113; number of passengers carried, 8,575,148. Total receipts, £35,762; working expenses, £17,225; interest and sinking fund, £6,385.

Broughty Ferry.—An electric lighting installation has been fitted up at the gasworks, all departments of the works except the retort house having been provided with electric light. This is truly a disinterested compliment.

Burmah.—The G.E.C. of America have secured the contract for supplying a complete electric installation for lighting the Sagaing-Amarapura ferry over the Irrawaddy River, Burma railways. The order, it is understood, has been let for £767, and delivery has been promised in 65 to 75 days from date of same.

Burton-on-Trent.—The Corporation electric light works were stopped on Tuesday owing to the floods.

Calcutta.—The business of the Calcutta Electric Supply Corporation, Limited, of which Messrs. Kilburn & Co. are managing agents, is increasing at an extraordinary rate. At the start in April, 1899, the lamps connected numbered only 750; after one year's working the connection was 14,000, and at the end of November last 27,000 lamps. Mr. K. A. Scott-Moncrieff, the company's engineer, returned to India last month, having arranged in England for the purchase of two 750-KW. steam dynamos.

Conway.—The T.C. wants expert advice on the advisability of adopting an electric lighting scheme.

Dartford.—Some progress has been made with the U.D.C.'s electric lighting proposals, the revised estimates being as follows:—Land and conveyancing, £1,038; machinery, £7,193; mains, £4,867; arc lamps, £184; building, £4,906; chimney shaft, £615; making a total of £18,803. The committee is now considering tenders, and the L.G.B. has sanctioned a loan for £20,000, the major portion of which is repayable in 25 years.

Dover.—The T.C. has resolved to employ Mr. Manville to report on the Electric Supply Company's undertaking at a fee of 50 guineas.

Dublin.—A report on the high tenders for the erection of the electrical power station at Pigeon House Fort was submitted to the T.C. by Mr. Hammond on December 21st, but the matter was adjourned. The members of the E.L. Committee who were surcharged by the L.G.B. auditor have decided to appeal to the L.G.B. with a view to having the auditor's action over-ruled.

Epsom.—Mr. N. K. North, C.E., one of the inspectors of the L.G.B., held a public inquiry last month into the application of the U.D.C. for sanction to borrow the sum of £2,793 as an extension of the loan of £16,100 already obtained for the purpose of carrying out the electric lighting installation. Mr. Hawtayne, the engineer, stated that the Council purchased Bromley Hurst on his advice in December, 1898, and he was instructed to prepare plans for carrying out the electric lighting scheme. The amount of the contracts recommended to the Council for acceptance was £10,894. In addition to the estimate mentioned, the Council would have to add the extra cost of buildings, estimated at £2,700. The present application was for the purchase of a strip of land for the purpose of a road to the site, cost of making the road, &c. The increase in the amount of the building contract was largely due to the considerable rise in the price of material and labour.

France.—The Municipal Council of Craponne-sur-Arzon (Haut Loire, France) will shortly ask for tenders for the electric lighting of the town.

Galashiels.—The T.C. has agreed to make application for a prov. order to introduce electric lighting into the burgh.

Grimsby.—At the new electric lighting station in Doughty Street, Grimsby, on Tuesday night, Ald. Dobson, chairman of the Lighting Committee, formally switched on the electric lighting of the station. Ald. Dobson said that within a month half Grimsby would have electric light.

Hebden Bridge.—The D.C. has decided to obtain a prov. order with a view to the supplying of electricity to the district, and has instructed Mr. Emmott, electrical engineer, Halifax, to report as to the cost of producing electricity by steam, gas, and water.

Fareham.—A L.G.B. inquiry was held last month into the application of the Council to borrow £500 for electric lighting.

Greenock.—The burgh electrical engineer, Mr. W. M. Nelson, in a report on the public lighting extension for the burgh, states that provision is made for the ultimate lighting of the whole of the tramway route by arc lamps, and that it is proposed to put lamps on every second pole. The engineer estimates the cost of fitting up arc lamps on the tramway poles at £21 per lamp, and if the complete scheme which he has prepared is carried out, 66 new lamps will be required in addition to those already erected, making a total of 110 lamps. The capital outlay for the extension would be £1,386, and the price of running could be brought down to £16 per lamp, making a total running cost of £1,760 for the 110 lamps, as compared with £880 for 44 lamps in use at present. The capital cost of putting up 44 new lamps and 45 incandescent lamps, the engineer says, would be £990, and the annual running charge £1,672. The length of way to be lighted, as proposed by the engineer, would be 4½ miles—only two being lighted at present by electricity.

Hendon.—The D.C. has received 82 tenders for plant, &c., in reply to its advertisement. They have been referred to Mr. Hammond for consideration and report.

The B. of T. has given formal sanction to the scheme of supply of electrical energy for the purposes of the Hendon Electric Lighting Order. The Council has decided to call a public meeting to ascertain the views of the ratepayers on the scheme. The Council has not yet obtained a site for the generating station.

Howwood.—It is proposed to light Howwood, Renfrewshire, with electricity.

Hoylake and West Kirby.—In accordance with the recommendation of the Electric Supply Committee, the U.D.C. has decided that the charge for the supply of electrical energy to churches and chapels shall be reduced to 5d. per unit, and for motors to 3d. per unit for the first hour and to 1½d. per unit for each subsequent hour.

Kingston.—The T.C. has resolved that application be made to the L.G.B. for a further loan of £2,800 for additional machinery at the electric lighting works. It is proposed to extend the line of arc lamps to the borough boundary in three directions, when there would be 72 arc lamps instead of 36, as at present. The application to the L.G.B., therefore, will be for a loan of £17,800 instead of £15,000.

Hampton.—The D.C. has resolved that application be made to the B. of. T. for a prov. order to supply electricity for public and private lighting and other purposes within the area of the urban district.

Leicester.—Some trouble has been experienced at the electricity works on account of the recent floods, which established a record on Monday last. The damage to the works is supposed to be unimportant, though the supply of electricity to the town was for a short time interrupted.

London.—The Metropolitan Electric Supply Company, Limited, whose area of supply includes the parishes of Paddington, St. Marylebone, the St. Giles's district, the Holborn district, and the Strand district, intend to apply to Parliament next session for powers to lay a second distributing system from their principal generating station. At the present time the company are dependent for their supply of electricity on a single line of cables passing from the generating station at Willesden along the towing path of the Grand Junction Canal to their several areas of supply. The second distributing system now proposed will be separate and distinct from the existing trunk main, and will run by an entirely different route to the various areas of supply, so as to enable the company to give an extra high pressure, and to better secure the continuance of the supply.

HAMPSTEAD.—The Borough Council has resolved that a contract be entered into with Messrs. Neil & Co. for construction of boiler foundations, flues, &c., in connection with the electricity station extension, for the sum of £3,094 4s. 6d.

MARYLEBONE.—The Borough Council has resolved to make application to the B. of T. for a prov. order to supply electricity for public and private purposes throughout the borough.

NOTTING HILL.—In order to meet the demand for electricity within the parish of St. Mary Abbotts, Kensington, says the *Financier*, the Notting Hill Electric Lighting Company are applying to Parliament next session for powers to acquire properties in Napier Road and Holland Mews, Kensington, for the purpose of providing an additional generating (? transforming) station.

ISLINGTON.—The Borough Council has adopted a proposal by the late Vestry for the provision of additional water storage, of a switch gallery along the engine house, and other works at the electric lighting station, at a total estimated cost of £6,606.

Machynlleth.—The D.C. have discussed the proposal to supply the means of lighting the town with electricity. Mr. E. Rees explained that he had obtained a long lease of water power at Garth upon very reasonable terms, and a London company, after going into the details, were prepared to send an engineer down to prepare a full set of plans for the scheme, and do all the work without asking for a single penny from the town. But they wished to know whether the Council would give their moral support to the application for a provisional order and allow them to lay the mains along the streets. The price of the light would at no time exceed 7d. per unit. It transpired that the proximate capital would probably be about £8,000, of which about three-fourths would be called up, but no binding resolation was passed.

Manchester.—During the year 1900 great progress was made by the Electricity Department. Whilst the number of consumers in December, 1899, was 3,014, with a demand equivalent to 328,696 8-C.P. lamps, there are now 3,646 consumers, with a total demand equivalent to 362,464 lamps. When the installation of the four 1,800-KW. Westinghouse generators is completed at Broom

Street, the station will have a total capacity of 12,000 H.P., and will be rather larger than the Dickinson Street works, which has taken seven years to attain its present size. At Dickinson Street two new Ferranti generators, each of 1,000 H.P., have been erected during the past year. Both these machines will shortly be ready to assist with the load, and they are intended to supply the energy which will be required for working the electric tramcars, which are to run on the three routes first to be taken over by the Corporation, viz., Cheetham Hill Road, Rochdale Road, and Bury New Road. With the completion of these two generators the whole of the space set aside for machinery at Dickinson Street is now fully occupied. The City Council, has confirmed the appointment of Prof. Kennedy to advise the Electricity Committee generally upon the schemes which are now in progress.

Melbourne.—Under the provisions of the Electric Lighting and Power Act, the Lieut.-Governor-in-Council has approved of the transfer of the orders and undertakings of Messrs. T. T. Draper & Co., to the Melbourne City Council. A new order has also been granted to the Electric Lighting and Traction Company, of Australia, Limited, embracing the metropolitan and suburban areas, and other transfers will be ordered at an early date.

Oran (Algeria).—M. Chassaigne, engineer, acting for a company formed for the purpose, has made a proposal to the town of Oran for the lighting by electricity of a district of 12 miles' radius, the estimated cost being £40,000.

Perth.—There were 87 applications for the post of electrical engineer. They have been remitted to a committee to prepare a short list.

Peterborough.—The electrical engineer to the T.C., Mr. Gill, has recommended that an additional generator be erected in the electricity works, of double the present output.

Rheims (France).—An important project is at present under study for the electric lighting of the valley of the Swipp and the Rheims mountain. The system will serve no less than 29 towns and villages.

St. Helens.—The borough electrical engineer, Mr. J. S. Highfield, has reported to the Electric Supply and Tramway Committee that the total number of electric lamps connected to the service up to November 10th was 18,864, against 10,209 at the corresponding date in 1899; the number of units sold for lighting purposes during November was 29,118, against 14,548; for tramway purposes 54,736, against 21,562; and for motors 9,023, against 1,846. The town clerk reported that he had informed the Westminster Electric Supply Corporation, Limited, that the Corporation approved of the effort being made to induce the Board of Trade to make arbitration compulsory when undertakers changed the pressure of the supply to consumers.

Sardinia (Italy).—In connection with an undertaking having for its object the collection of the waters of the Tirso and adjacent rivers in the plain of Campidano d'Oristano for the purposes of a water supply, an important electrical project is at present under study. It consists in converting the latent energy of the reservoir into motive power, and M. Merlo, engineer and vice-president of the French company "Des Mines de Malfido," has submitted a proposal to the Mining Society of Iglesias (Sardinia) in this connection. The proposal is in effect to transmit this energy to numerous mines in the province within a radius of 36 miles. The reservoir will store on an average 30 million cubic metres of water, so that the energy secured by this means would be considerable. The cost of the electric project alone is estimated at £220,000. It is calculated that an economy of 50 per cent. would be effected in the mines by the adoption of electricity.

Scotch Power Schemes.—The promoters of the Caledonian Electric Power Co. seek a capital of £1,000,000, and propose the erection of electrical generating stations and works for the production and distribution of electricity within certain portions of the counties of Lanark, Dumbarton, Renfrew, and Ayr. A schedule specifies the positions of the proposed generating stations to be at Renfrew, Knock, Port Glasgow, Cardross, Blantyre, Kilmarnock, and Irvine. Similar powers are asked for by the Clyde Valley Electrical Power Company. The area is slightly different. The capital is £900,000. The area of supply is part of the counties of Lanark, Renfrew, Dumbarton, and Stirling.

Sleaford.—The L.G.B. has granted the application of the U.D.C. for permission to borrow £7,000 for the initial cost of an electric light installation. The application was strenuously opposed by ratepayers representing £14,000 out of an assessable value of £18,000, on the ground that the proposed scheme was inadequate.

Stourbridge.—The D.C. has resolved that an application be made to the B. of T. to extend by two years the period during which the Council's prov. order may be utilised, and that the application of the Midland Electric Corporation for powers in the Council's area be opposed.

Swadlincote.—The B. of T. recently inquired whether the D.C. had taken any steps to carry out its prov. order. In reply, the D.C. asked for an extension of time.

Sydney.—The Minister of Works intends to act upon the report of Mr. Raw of his department with respect to the utilisation of the waters of the Grose River for the generation of electric power, and will probably offer a bonus for the best and most complete scheme for carrying the project into effect.

Wimbledon.—The electric lighting works of the U.D.C. have been working at full pressure for several weeks past, with the result that there have been serious complaints as to the inefficient supply of current in those parts of the district farthest away from the generating station. As a temporary remedy, the Council has purchased a booster for the purpose of raising the pressure on the longer cables, and it is anticipated that this step will also avoid the frequent excessive pressures on the nearer ends of these circuits. It will be two or three months before the generating plant can be increased to meet the ever increasing demand among private consumers.

ELECTRIC TRACTION NOTES.

Aberdeen.—The electric cars on the Woodside route, inaugurated by the Corporation 12 months ago, have during the year carried about 3,000,000 passengers, the fares from whom, roughly speaking, would amount to £11,000.

Bombay.—We read in *Indian Engineering* that the report presented to the Corporation by the Committee appointed to consider the questions affecting the tramways recommends that the present tramways company be invited to make an offer for the renewal of the concession, on the understanding that electric traction will be introduced within three years, and that the Corporation have the option of purchase on the basis of actual value without the good-will.

Central London Railway.—A breakdown occurred on the Central London Railway on 28th ult. at about 9 o'clock a.m., near Notting Hill Gate Station. It is stated that part of the brake gear of one of the coaches had become detached, and was touching the centre rail, thus causing a short circuit and fusing the circuit breaker at the sectional sub-station. This had the effect of cutting off the current from the east-bound track and causing all trains to come to a standstill. Traffic was not resumed until 10.45.

Cardiff.—A deputation from the Tramways Committee is to visit various towns and works to select a suitable type of car for electric traction. The cost of the cars required is put down as about £80,000.

City and South London Extensions.—The Bill which will be introduced into Parliament next session for the incorporation of the "Islington and Euston Railway Company," is, says the *Financial Times*, in reality an extension to Euston of the City and South London Railway from their authorised extension to Islington. The chairman of the City and South London Railway Company, Mr. Charles Grey Mott, is the promoter first named in the Bill, his co-directors on the board of the new company being Mr. Charles Seymour Grenfell, Mr. Edwin Tate, and Mr. David Sydney Waterlow. The Bill now deposited, contains all the necessary clauses for working the railway as a separate and independent undertaking, but the preamble recites that the "railway could be conveniently and advantageously worked by the South London Company," and clauses are inserted to enter into agreements with that company for working the railway, for the supply of electricity, for the employment of officers, and for the appointment of a joint committee to carry into effect any agreements. As an independent company the capital proposed to be raised is £420,000, divided into 42,000 shares of £10 each, but with power to sub-divide the shares into "preferred half-shares" and "deferred half-shares." Upon this capital borrowing powers are sought to be exercised to the extent of £140,000, but with the right to expend £33,000 of the share capital in the payment of interest during the construction of the line. The Bill contains a clause binding the company to run "at least 12 trains in each direction before the hour of seven in the morning on every week day" at a charge of "not more than ½d. per mile," with a minimum of 1d. for each ticket.

Dudley.—On Tuesday an electric car driver at Queen's Cross lost control over the brakes, with the result that his car, when descending a hill, left the metals, and coming in violent contact with one of the iron standards, knocked it down. The car was thrown across the road, the passengers, five of whom were seriously injured, being precipitated into the roadway.

Finchley and Hendon.—The Middlesex County Council have decided to oppose that portion of the Bill promoted by the Charing Cross, Euston, and Hampstead Railway which includes electric tramways from Golder's Green to Finchley and Hendon, on the ground that the Light Railway Commissioners were not prepared to include certain tramways of which the above are a portion, and that the Council will, at some future date, apply for authority to lay down the lines in Hendon themselves. The County Council have appointed a Light Railways and Tramways Committee, to take charge of the construction, control, and management of light railways and tramways which may belong to the County Council.

Gillingham.—The Chatham, Rochester, and Strood Electric Light Company is to be approached by the Council with a view of acquiring the works and rights of the company. Chatham and Rochester are proceeding in the same direction.

Glasgow.—The sub-committees of the Tramway and Lighting Departments have been conferring together in reference to the position of the tramway poles in the centre of Great Western Road. The Lighting Committee intimated that it was not advisable

to light Great Western Road with electric lights, incandescent gas lights being, in their opinion, more suitable, and it was accordingly resolved by the Tramway Sub-committee to recommend that the tramway poles be removed to the side of the street. We were under the impression that incandescent gas was not admirably suitable for street lighting; the excellent effect produced by using arc lamps for the electric lighting of wide public thoroughfares, and the artistic appearance of combined central poles, render it, to say the least of it, quite unnecessary to go to the trouble of removing the trolley standards from the centre to the sides of the thoroughfare. There are plenty of places where Glasgow deputations can see, or have seen, arc lamps suspended from centre trolley standards with the best possible result.

Greenwich to Catford. — The South-Eastern Metropolitan Tramways Company has applied to the Board of Trade for approval to the reconstruction and electrical equipment of the company's tramways from Greenwich to Catford upon the Schuckert surface-contact system, and has now informed the Greenwich Borough Council that the Board desires to learn the views of the several local and road authorities concerned.

Hoylake and West Kirby.—The District Council has decided to oppose the project for the construction of a light railway connecting the district with Birkenhead, Wallasey and New Brighton, Cheshire.

Liverpool.—For the fortnight which ended with December 22nd, the receipts from the Liverpool electric tramway system were £16,626 10s. 6½d. This was an increase of £11,374 10s. 8½d. over the amount for the corresponding fortnight last year, due to the great extension of the service. The mileage for the fortnight was 357,269, an increase of 139,471 miles over the same period last year. 3,594,782 passengers were carried, an increase of 2,191,636. There are at present 250 electric cars running, against 181 at the same date last year.

A deputation of residents from the Edge Lane district of Liverpool (East) waited upon the Tramways Committee of the City of Liverpool on Friday last to ask, among other things, that the electric car system might be carried along Edge Lane. In reply, Alderman C. Petrie, chairman of the committee, said that an application would be made to Parliament next session for powers to construct a tramway there.

A telephone wire fell across a trolley wire last week, and a cab horse received a shock which incapacitated it for a time.

Nottingham.—The Market Place to Sherwood section of the new Nottingham electric tramways was opened for public use on New Year's Day.

Palermo.—Mr. de Garston, in his report on the trade and commerce of Sicily, speaks of electric trams and light in Palermo as follows:—"The laying down of the electric tramway to replace the present horse service has proceeded satisfactorily during the latter half of 1899, and will be a great improvement to Palermo; not only are the existing tramway lines to be transformed, but new lines will be laid, notably a specially constructed and worked track from La Rocca to Monreale, which will be exceedingly handy for the numerous tourists and visitors who annually flock to visit the magnificent cathedral. The tramway company in order to obtain the necessary sanction for the extension of its lines found it expedient to offer a premium of 1,000,000 lire (£40,000) to the municipacity of Palermo as an incentive for certain concessions, which were not, however, accorded. Large workshops have been established at the Arenella, a suburb of this city, for the construction of the tramcars by a local firm, and these are furnished with excellent modern machinery, the cars turned out being apparently in every respect satisfactory. The Via Macqueda, one of the principal thoroughfares intersecting this city, is now lighted by electricity, which is supplied by the works of the tramway company; private consumers are also furnished by the same company. The price, however, is still apparently too high for electricity to be generally introduced into private households, and moreover there does not seem to be any liklihood of the cost being lowered."

Underground Railways.—At a meeting of the Court of Common Council last week Mr. Deputy Johnson called attention to the fact that other tube railways were projected for London, and asked what was the legal position of ratepayers who alleged that they suffered from the effects of the vibration caused by the existing railway. The Remembrancer said about six electric railway Bills had been deposited in Parliament for the ensuing session; but it would not be known until the middle of next month on which of those Bills the 5 per cent. deposit on the capital had been paid. He suggested that the sufferers from vibration should ascertain full and accurate data in respect of their respective basements. The Board of Trade had taken exceptional steps to ascertain the facts for itself. He believed that the persons who considered themselves seriously affected might place their cases before the Board of Trade for investigation.

TELEGRAPH AND TELEPHONE NOTES.

British Telegraph Lines in Persia.—Reuter's agent at Teheran says that the Persian Government is making arrangement for putting a stop to the wilful damaging of British telegraph lines in Persia which has occurred somewhat frequently of late, seriously endangering telegraphic communication between Europe and India. The Persian Government has now issued a firman ordering local Governors to take special measures to protect the lines, and holding them responsible for any wilful damage done in their several districts.

African Telegrams.—It is announced in the *London Gazette* that the following reductions are to be made in rates for telegrams to South and Central Africa, and to the islands of Ascension and St. Helena, as from January 1st:—

	For each word.
Cape Colony, Natal, Orange River Colony, Transvaal, Zululand	s. d. 3 6
Ascension	3 6
St. Helena	3 6
Swakopmund (German South-West Africa)	3 8
Southern Rhodesia, Northern Rhodesia	3 8
British Central Africa (Nyassa'and)	3 11

Cape to Cairo Telegraph.—With regard to the Cape to Cairo telegraph, the *St. James's Gazette* understands that the line has now been laid to a point 50 miles beyond Kasanga, in German East Africa, and 100 miles beyond the southern end of Lake Tanganyika. Nearly 3,000 of the total 5,600 miles have been completed from the Cape, while the Egyptian telegraphs run south for about 1,700 miles, leaving over 1,200 miles to complete. Much less difficulty has been experienced with the natives than was expected, though the line runs through the territories of many warlike tribes. So far from destroying it, however, they are rendering assistance in the construction. At first the constructors would give the natives an electric shock or two, and after that the line became a fetish with which they would not meddle at all. Little or no damage has been done by wild beasts or the unwieldy elephant. The great obstacles have been in cutting through almost impenetrable forests where trees would fall on the line. Another consideration is the enormous difficulty of transport, the carrying of all the material thousands of miles by rail and boat. All the material has been got out for the construction of the line through German territory, leaving only British East Africa to be spanned. The rates will be considerably lower than the 3s. 6d. per word now charged by the marine cable companies from Cape Town to England.

Growth of the Telephone Service.—The following table, showing the receipts of the Post Office from the telephone service, has been compiled in response to an order of the House of Commons. It shows at a glance, says the *Times*, the very remarkable change which the last 20 years have witnessed as regards the use of the telephone. The figures are as follows:—

In respect of the year to March 31.	Royalties from licensed companies.	Revenue from local exchange business.	Revenue from trunk line business.	Total.
1881 ..	£205	—	—	£205
1882 ..	6,905	£1,868	£133	8,906
1883 ..	11,301	9,331	174	20,796
1884 ..	16,063	16,223	548	32,834
1885 ..	18,813	21,694	908	41,415
1886 ..	22,430	25,433	1,189	49,052
1887 ..	26,170	22,786	1,812	50,268
1888 ..	28,345	24,864	1,553	54,662
1889 ..	34,099	25,628	1,914	61,641
1890 ..	39,935	26,806	2,575	69,316
1891 ..	43,495	27,697	3,283	74,475
1892 ..	46,528	23,646	8,612	78,786
1893 ..	56,501	23,826	10,138	90,465
1894 ..	63,395	25,031	11,342	99,768
1895 ..	70,990	21,609	14,575	107,174
1896 ..	79,676	21,603	24,207	125,486
1897 ..	85 289	21,034	113,294	219,617
1898 ..	95,237	20,172	145,325	260,734
1899 ..	110,195	21,644	182,525	314,364
1900 ..	130,272	22,338	207,417	360,027

A similar Parliamentary return was issued on 1st inst., says the *Times*, showing the amounts paid by the District Messenger and Theatre Company, Limited, to the Post Office, and of the payments made by the Post Office to the company, year by year, from the commencement of their license. The payments made by the company to the Post Office are comprised under two heads—first, revenue collected by the company on behalf of the Post Office; and, secondly, royalty and wayleaves on telegraphs. Under the first head there was paid to the Post Office, for the year 1897-98, £1,103 8s. 7d.; 1898-99, £1,971 5s. 8d.; and 1899-1900, £1,827 11s. 5d. Under the second head there was paid, during the same years, £264 18s. 6d., £408 11s., and £344 13s. The payments made by the Post Office for work done by the company for the department were—1897-98, £275 17s. 2d.; 1898-99, £586 15s. 4d.; and 1899-1900, £1,119 12s. 7d.

Russian Telegraphs.—A press correspondent at St. Petersburg says that with a view to accelerating the tardy transmission of telegrams between St. Petersburg and the remote districts of the Empire, the Imperial authorities have resolved to abolish many intermediary stations. Hitherto, a telegram sent from the capital to Tiflis has had to be dealt with at 14 stations *en route*, and one sent to Irkutsk has had to pass through 13 stations. As an accelerated telegraphic service both with the Caucasus and the Far East is of immense importance at the present juncture, the intermediary stations have been reduced to four and six respectively between Tiflis and Irkutsk.

(*Continued on page* 25.)

COAL AND ASH HANDLING, AND STORAGE PLANTS FOR ELECTRIC LIGHT AND POWER STATIONS.

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I.

THE enormous increase in the consumption of coal in electric light and power stations demands the introduction of the most economical methods of handling the material. The commercial basis of electric light works is cheap steam, and, therefore, the problem to be solved is :—The best method of producing steam on the cheapest lines.

The bulk of electric light and power stations have either a railway siding, or are located adjacent to a canal or waterway.

The supplies of coal are generally intermittent, and are delivered in quantities from 60 to 600 tons at a time; the absolute necessity for handling this bulk as speedily as possible and with a minimum of labour, warrants the most careful consideration being given to the planning out of a plant by the engineer and manager.

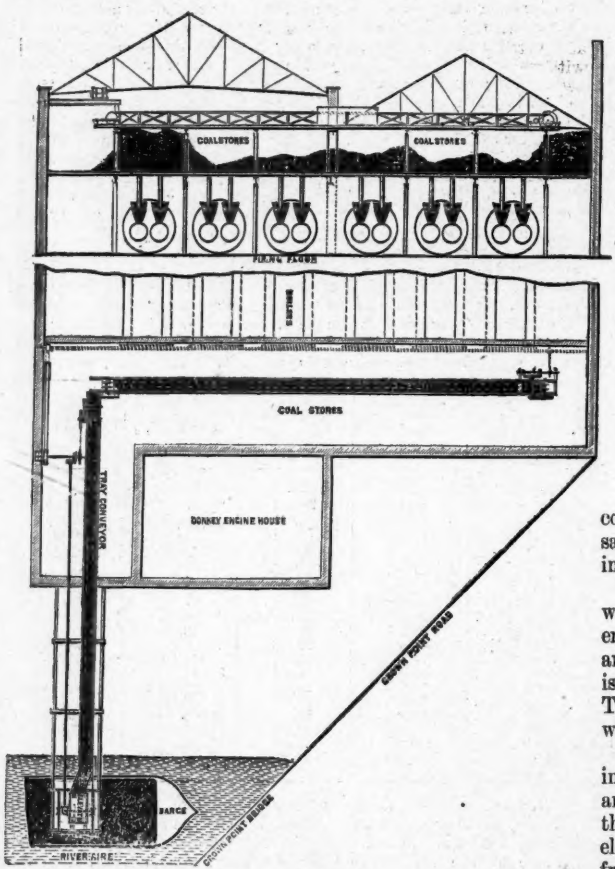
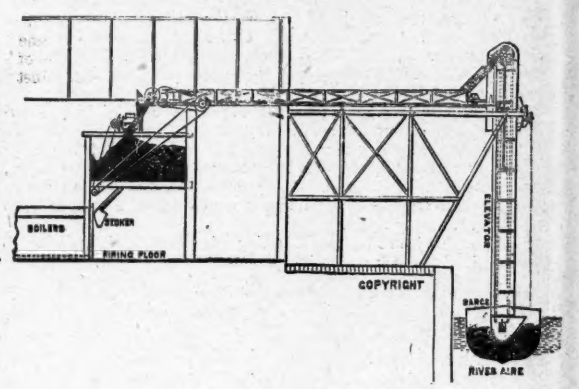


FIG. 1.—PLAN.



VERTICAL SECTION.

When the coal is once handled in the barge, boat or truck, it should be delivered to the coal stores or bunkers, over or near the boilers, without being touched again by hand labour. By this means, if a judicious design of plant is adopted, the coal can be handled at an average rate of ½d. per ton.

In gas works, collieries, steel works, &c., where thousands of tons of coal are dealt with daily, the works are generally equipped with the latest improvements in coal-handling apparatus, and electrical engineers should give every consideration to the methods and principles adopted in such works for handling large and small coal with the same apparatus, seeing that they represent the results of many years' experience and carefully thought-out experiments, based on a large tonnage and daily output of of coal. The electrical engineer should prepare himself for the consumption of both large and small coal, and in introducing coal-handling plant, due consideration should be given to each item of detail, according to the position of his works, so that he is prepared to battle with the very worst circumstances that he may encounter. A suggestion, therefore, that he should consider more ways than one of receiving and dealing with his coal supplies, with a view to the adoption of that system which gives the maximum of reliability with the minimum of expense and labour, is timely advice. Unfortunately, many electrical engineers do not give the attention they should to this problem, owing, no doubt, to the fact that their previous experience has been confined to the other branches of electrical engineering, where, perhaps, more enticing and interesting results can be obtained, and where the work is of a more congenial, pleasant, and cleaner character.

It is an old saying that "Where there's dirt there's money," and in the boiler houses of many electric light and power stations dividends are either made or lost.

It is a wise plan to spend money judiciously in obtaining the best and latest information, and to make a tour of inspection of what is being done at other works; also to obtain the advice and assistance of manufacturers who make this class of plant their special study, as no doubt they would help applicants to attain their object at a considerable reduction in capital expenditure, and at the same time they would point out the latest inventions and improvements.

To make this series of articles all the more interesting, we propose describing several installations which have been erected, and which offer several suggestions both for storing and handling coal. We will commence with a plant which is working at the electric tramway power station, Leeds. This plant was erected for the purpose of unloading barges which contain about 80 tons of small boiler coal each.

Fig. 1 is a diagram sketch showing the elevator lowered into the barge and all in working order. This elevating and conveying plant is capable of raising and storing coal at the rate of 35 tons per hour. As shown on figs. 1 and 2, the elevator is completely cased in with steel sheets and angle iron framing, and is provided with a special-shaped elevator bucket 24 inches wide, with a deep back, so that when raising the coal a correct delivery is obtained at the highest point of the elevator. This special design of bucket is necessary owing to the fact that the elevator is working in a vertical position. It is provided with a double strand of stamped steel roller chain, each strand having a breaking strain of 12 tons. The centre to centre, or length of the elevator, is 35 feet. Upon an inspection of the design, it will be noticed that a steel structure composed of joist work is fixed on the river side and projects a distance of about 8 feet; this is for the purpose of supporting the elevator and steel tray conveyer. The elevator is raised and lowered by means of two drums, attached to which are two ¾-inch diameter wire ropes, the drums receiving their motion from the vertical shaft, which is directly geared to the main driving shaft. The raising and lowering motion can be operated from the ground line by means of a hand-wheel and shaft connected to a double friction clutch, and the speed of raising and lowering is about 1 foot per minute.

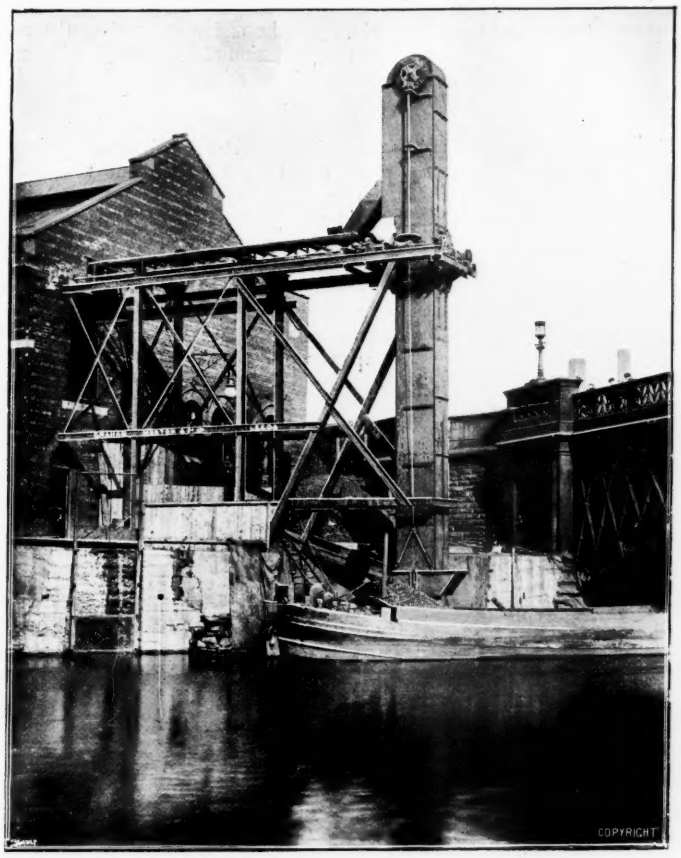


Fig. 2.

It has been found in practice that it is not advisable that the speed of the raising and lowering should be any greater than that arranged for in this plant, otherwise there would be a risk of the attendant doing some damage to the boat.

It will be seen that the elevator delivers the coal on to the steel tray conveyer, which is 2 feet wide, and composed of steel plates overlapping one another, so as to form a continuous belt. This style of conveyer is largely adopted in collieries and gasworks for handling large and small coal, in fact, it is the only class of conveyer found serviceable at the present time for handling the "largest coal" which comes up the pit, and at the same time it handles with equal success the smallest dust, or slack. This class of conveyer in gasworks is used for carrying coke, oxide, &c., and in the large coke storage plants erected in many works, the material can be distributed at any point along the conveyer by means of movable ploughs.

The speed of travel of this class of conveyer ranges from 43 feet to 100 feet per minute, according to the circumstances.

Fig. 3 is an instantaneous photograph of the plant when working, and it will be seen that the coal is distributed quite evenly over the width of the conveyer. This steel tray conveyer delivers the coal on to a push plate conveyer which is shown on fig. 1, both in the plan and elevation. The latter conveyer is fixed the whole length of the coal store, which runs directly over the boilers, the coal being distributed into the first portion, then pushed along the trough until it arrives at an opening, when it falls into the stores, and the heap accumulates until the opening is blocked up, when the conveyer scrapes the next portion of coal over this opening and deposits it through the next aperture. Consequently, the action of the conveyer is entirely automatic, and the attendant, by opening all the slides in the trough of a conveyer of this design, can completely fill the coal stores with very little attention.

Attached to the lower side or floor of the coal stores are a series of steel shoots, two to each boiler, so that an automatic feed is obtained for the mechanical stokers. The whole of the plant is driven by an electric motor which is fixed on the coal stores floor, and which drives the main shaft of the conveying plant by means of belt, chain, and spur and pinion gear. The horse-power required to drive the apparatus is very little.

The number of men working on this plant when unloading a barge is two, and the cost of handling the material from the barge and depositing the same in the coal stores is about ½d. per ton for wages. The method of unloading the boat is by lowering the elevator into the centre of the boat and allowing it to dig a hole for itself, until it reaches the bottom of the boat. The boat is then travelled along gradually to obtain an automatic feed for the elevator.

The elevator is then raised and operates on the stern of the boat, and

Fig. 3.

in a similar manner digs a hole to the bottom and empties a large portion of the coal, but to prevent any possible chance of sinking, the elevator is raised again and operates on the bow of the boat to a like degree. It is then possible, after balancing the boat in this manner, to take the coal from any position. Messrs. Graham, Morton & Co., Leeds, erected this plant under the supervision of Mr. T. Hewson, city engineer, and Mr. Kidd.

Beckenham.—View of Station Buildings.

BECKENHAM ELECTRICITY WORKS.

As in the case of so many local authorities, the Beckenham Local Board obtained a provisional order for electric lighting so long ago as the year 1890, and a report on the subject was drawn up by Mr. Gisbert Kapp in 1893. There, however, the matter rested until 1897, when Mr. J. A. Angell, engineer and surveyor to the District Council, submitted an outline scheme for an electricity works combined with a refuse destructor. As a result of this, and under pressure from the Board of Trade, who proposed to revoke the order, the Council appointed Mr. R. P. Wilson to prepare a detailed scheme in conjunction with Mr. Angell; a Local Government Board inquiry was held by Colonel Slack in 1899, and sanction granted to a loan of £37,000.

Tenders were invited for the equipment of the generating station and destructor, and the following contracts were entered into:—

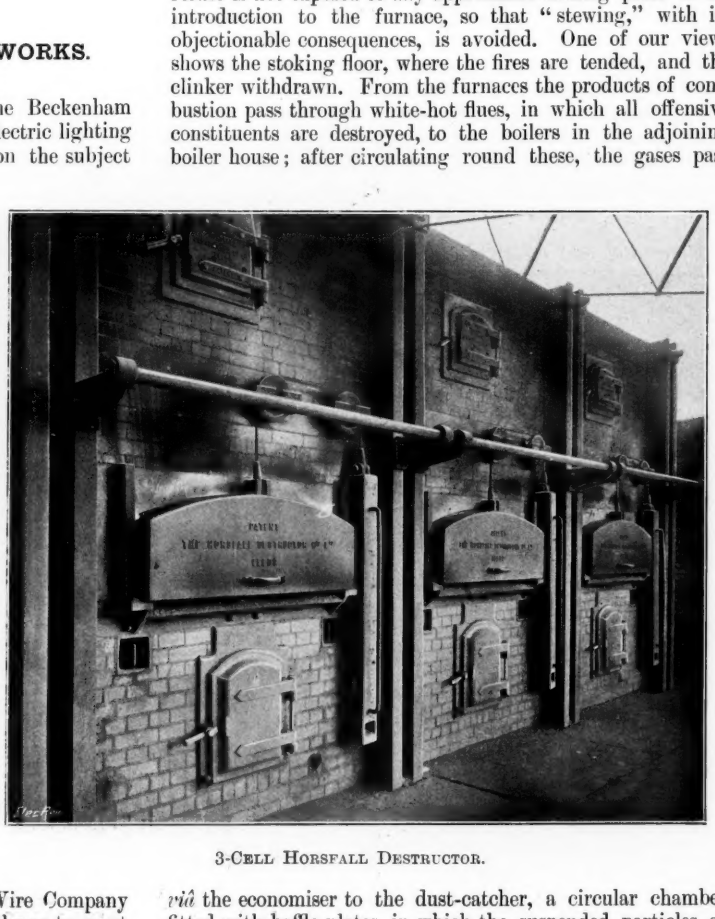
Buildings and approaches, Messrs. Nightingale	£9,500
Destructor, Messrs. Horsfall & Co....	2,500
Steam alternators and switchboard, Messrs. Fowler and Co.	6,600
Boilers, economiser, and steam pipes, Messrs. Babcock & Wilcox ...	3,300
Cables, The British Insulated Wire Company	14,400
Arc lamps, Messrs. Lucy & Co. ...	600
Travelling crane, Messrs. Chatteris and Co.	160

Before accepting the tenders, offers were invited for the working of the station and destructor for a period of five years; the tender of the British Insulated Wire Company was accepted, according to which the Council was to erect the works complete, while the company undertook to pay the whole of the charges for interest on the loan and sinking fund, &c., while receiving the whole of the revenue for the five years aforesaid. At the end of that time the undertaking passes into the possession of the Council without any payment whatsoever. The advantages offered by this system, as we have pointed out on other occasions, are very considerable; while the municipality is assured that that bugbear of the local authority—a monopoly in private hands—will not be created, it gets rid of the trouble and worry incidental to the getting under way of the enterprise, and is relieved of the possible loss on the first one or two years' working, with its accompanying tendency to recriminations and discontent on the part of the rate-payers.

The high pressure alternating current system has been adopted for distribution, power being generated at 2,000 volts and transmitted to sub-stations, from which it is distributed on the three-wire system, with 200 volts pressure on consumers' terminals.

The generating station is a brick building, not altogether devoid of ornamentation, situated on a site providing abundance of space for extensions, and so far removed from habitations that there can be little fear of annoyance to residents, either by vibration or by sentimental considerations regarding the destructor. It consists of the destructor and approaches, boiler and engine rooms, and offices.

The destructor is of Messrs. Horsfall's ordinary type, with three cells. The refuse is carted up the inclined approach to the tipping platform, whence it falls opposite the feeding doors, through which it is pushed upon the grate. The refuse is not exposed to any appreciable heating prior to its introduction to the furnace, so that "stewing," with its objectionable consequences, is avoided. One of our views shows the stoking floor, where the fires are tended, and the clinker withdrawn. From the furnaces the products of combustion pass through white-hot flues, in which all offensive constituents are destroyed, to the boilers in the adjoining boiler house; after circulating round these, the gases pass *viâ* the economiser to the dust-catcher, a circular chamber fitted with baffle plates, in which the suspended particles of dust are deposited, and finally the gases escape to the chimney. The dust-catcher and chimney may be seen in our view of



3-Cell Horsfall Destructor.

the station buildings, together with the approach to the tipping platform.

The boilers are three in number, of Messrs. Babcock and Wilcox's well-known type, working at a pressure of 160 lbs. per square inch. They are ordinarily heated solely by the gases from the destructor, but they are also provided with grates, by means of which they can be hand-fired with coal when desired. A water storage tank of 6,000 gallons capacity is situated aloft in the boiler room, and a No. 9 Boby heater detartariser is provided. Feed water is derived from a well sunk on the premises, whence it is lifted by a Mumford steam pump to the storage tank. Two Evans feed-water pumps are installed, and the feed-water piping is in duplicate throughout. The economiser consists of 96 tubes, and provision is made for passing the feed water either through the economiser, or direct to the boilers.

The steam piping is in duplicate, the two ranges being independently connected with each boiler and engine, and having a Belliss & Morcom steam separator attached; the steam pipes are of wrought steel lapwelded, with mild steel flanges, and are slung from brackets. The branches to the engines are carried overhead, while the exhaust pipes are led downward beneath the floor to a common main, which discharges direct into the atmosphere.

The engines are of Messrs. Belliss and Morcom's high speed vertical compound type, with forced lubrication, and are coupled direct to the alternators; the latter are mounted on separate bedplates. Two of the sets are rated at 120 KW. each, at 380 revolutions per minute, while a smaller set of 60 KW. capacity, at 500 revolutions per minute, is also provided. The speed of the engines is controlled by throttle governors, mounted direct on the main shafts.

The alternators are of the Leeds and London type, supplied by Messrs. Fowler & Co. All three have stationary armatures, and rotating field magnets with outward y-directed wound magnet cores and pole-pieces. The larger machines have 16 poles each, and give 60 amperes at 2,000 volts; the armature is arranged so that the frame can be drawn apart on the centre line, the bedplate being provided with slides for this purpose. The exciter armature is carried overhung on a prolongation of the main shaft, and is of the ring type, with a large commutator and gauze brushes; the exciter field is of the Manchester pattern.

The small alternator is similar to the larger ones, but is built for an output of 30 amperes at 2,000 volts, and the field magnet has 12 poles.

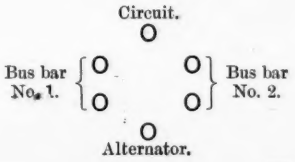
The frequency in each case is 50 periods per second.

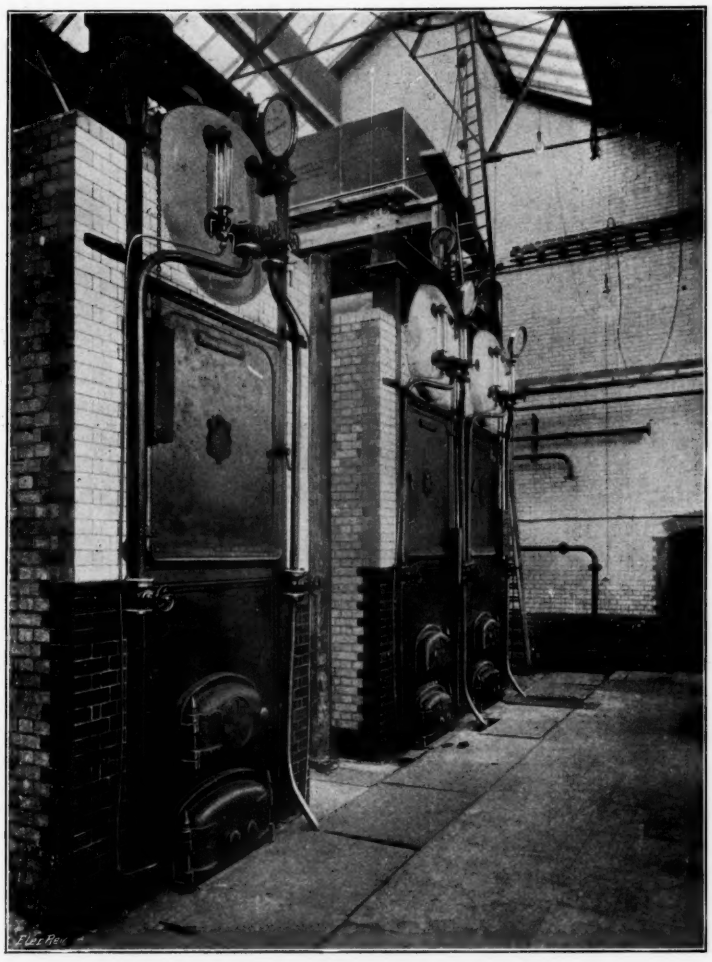
The engine room is traversed by a travelling crane for a load of 10 tons, built by the Chatteris Engineering Works Company.

The main switchboard is carried on a gallery at a considerable height above the engine room floor. It was supplied and erected by Messrs. Fowler & Co.

The board provides for three alternators and exciters and six circuits. It is built of black enamelled slate, and all charged metal work is carefully shielded from personal contact by means of white porcelain insulators.

There are two bus bars, arranged so that any alternator or feeder circuit can be connected with either bar, but not with both. For this purpose plug switches are used, as follows :—





Babcock & Wilcox Watertube Boilers.

Single-pole fuses are used on the alternator armature circuits, the outer conductor of the feeders, and one pole of the armature being connected direct to the outer bus bar, which is earthed.

The alternator fields, as well as the exciter fields, are provided with regulating rheostats on the board. Ammeters are used in all circuits, and the usual bus bar, alternator, and synchronising voltmeters are provided.

The measuring instruments are of Messrs. Nalder Bros. & Thompson's manufacture, with the exception of a small Kelvin recording voltmeter, and nine Kelvin multicellular voltmeters.

The parallelling instruments are mounted on a swing bracket, so as to be visible from any part of the switchboard gallery.

The cables were all supplied by the British Insulated Wire Company, and are of their usual lead-covered, paper-insulated type.

The high pressure feeders (six in number) supply the nine sub-stations, situated respectively at Cator Road, Technical Institute, Council Yard, Coperscope Road, Southend Road, Albemarle Road, Kemerton Road, Shortlands Road, and South Hill Park. Feeders 1, 2 and 3 supply two sub-stations each.

Each sub-station has its own low pressure network, the transformed pressure being 400 volts and 200 volts on the three-wire system, with triple concentric cables.

The low pressure network has disconnecting boxes fitted at junctions of all roads, enabling additional services to be connected to any part of the network without disconnecting or shutting down the remainder. A twin pilot cable is laid

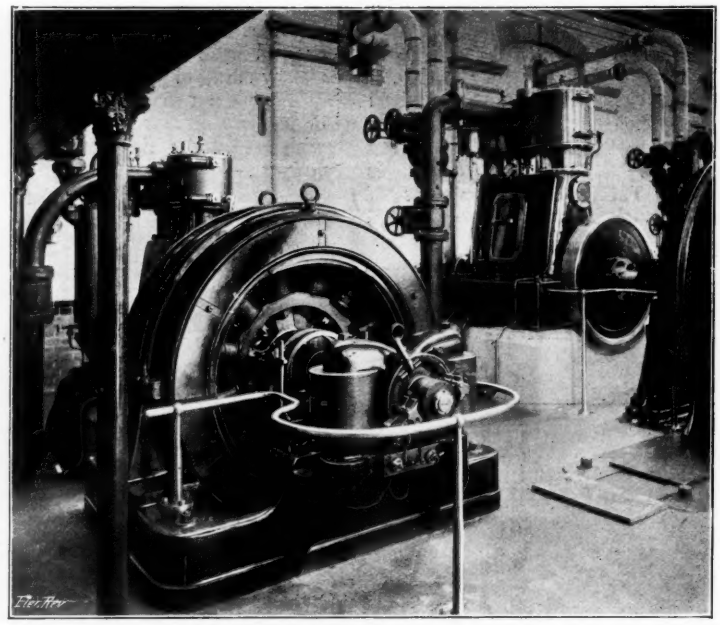
from each sub-station to the central station, which can be used as a telephone cable when required.

The nine sub-stations are all above ground, and are built of red brick with tiled roofs. The transformers and switch gear were supplied by Messrs. Fowler & Co.

Seven sub-stations only are connected at present: the other two networks (Shortlands and South Hill Park) have been supplied by the Bromley Electric Light and Power Company for the past 12 months, but will be taken over at an early date.

At these points the power is transformed to a pressure of 400 volts for distribution on the three-wire system.

The number of lamps at present connected with the mains is 6,500 of 8-c.p. each, and is rapidly increasing. In order to encourage the adoption of electric lighting, the Council has adopted a system of "free" wiring; 6d. per unit is charged for supply, and if the energy used amounts to 18 units per 8-c.p. lamp per annum, no further charge is made. If, however, the energy used is less than 18 units per 8-c.p. lamp per annum, an extra charge of 1d. per lamp is made for each unit by which the consumption per lamp falls short of the above value.



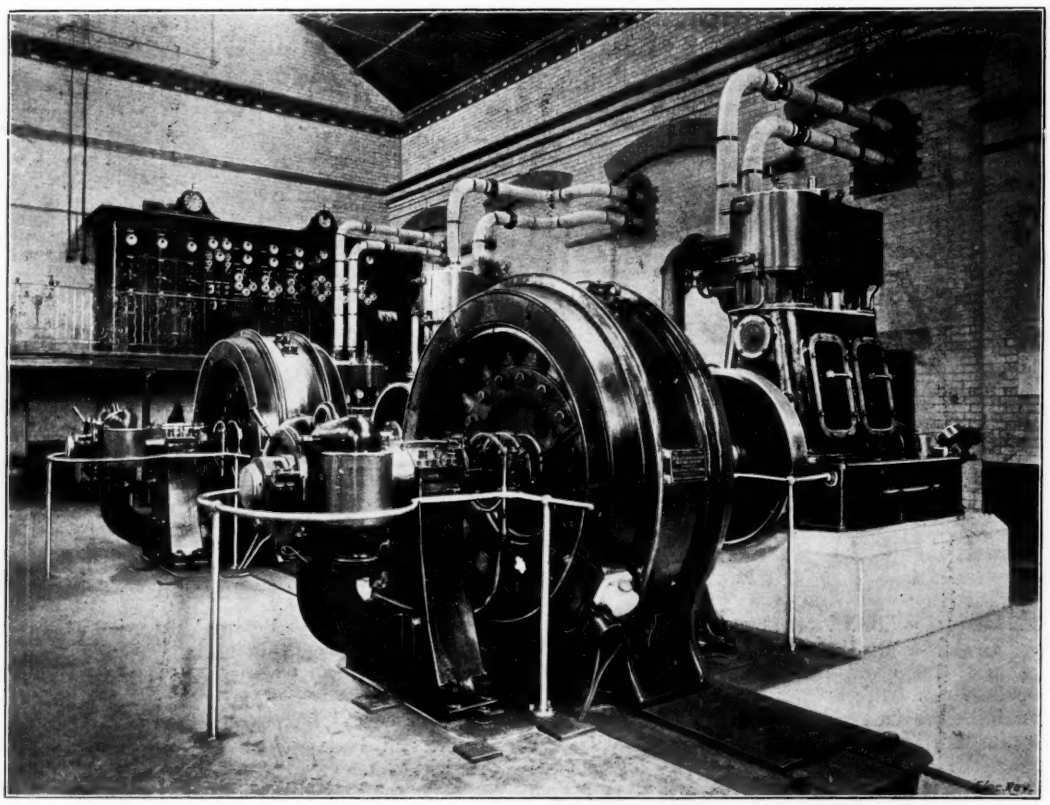
60-kw. Steam Alternator and Exciter.

Consumers who wire their premises at their own cost receive a reduction of 10 per cent. Arrangements are also made for the purchase of the installation by annual instalments.

Forty-two miles of cables have been laid, in stoneware troughs filled up with bitumen, and 18 arc lamps have been erected for public lighting. The present capacity of the station without reserve is about 15,000 8-c.p. lamps installed, exclusive of the public lamps, but it is anticipated that extensions will be necessary within the next 12 months.

The station was formally opened on November 22nd, 1900, by Mrs. Coles, wife of the chairman of the Beckenham Urban District Council.

The success of the scheme, we understand, is largely due in the first instance to the efforts of Mr. Angell, the surveyor, and Mr. Stevens, the clerk to the Council. The installation was carried out jointly by Mr. R. P. Wilson,



General View of Engine Room.

consulting electrical engineer, and Mr. J. A. Angell; Mr. H. Hastings has acted as clerk of works, and Mr. A. J. Hedgcock, representing the British Insulated Wire Company, has been appointed resident electrical engineer, to run the station during the period of the company's tenure. Our thanks are due to these gentlemen for their kind assistance in the preparation of this article.

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 19.)

London-Brussels Telephones.—The Central News says that by a treaty just concluded direct telephonic communication will be opened between Brussels and London next February.

Sydney Telephones.—In consequence of the interruptions of the telephone service by electric tramway currents, the metallic returns are to be introduced almost immediately in place of the earth return of the telephone system.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
AFRICAN—St. Louis (Senegal)-Bathurst	Aug. 25, 1900	.. ..
St. Louis (Senegal)-Teneriffe	Dec. 18, 1900	.. ..
SOUTH AMERICAN—Pará-Maranham	March 1, 1900	.. ..
Pernambuco-Ceara	Nov. 29, 1900	.. ..
Cayenne-Pinheiro	Nov. 26, 1900	.. ..
Barcelona - Guanta - Cumana - Portlamar-Carupano (Venezuela)	Nov. 1, 1900	.. ..
Bolamo-Bissao	Dec. 27, 1900	.. ..
Falmouth-Bilbao	Dec. 28, 1900	.. ..
Latakia-Cyprus	June 20, 1899	.. ..
LANDLINES:—		
SOUTH AMERICAN—Communications with all offices of Colombia beyond Buenaventura	January 22, 1900	.. ..
Interior of Colombia landlines	Nov. 19, 1900	.. ..
Ecuador landlines	March 8, 1897	.. ..
Landlines west of Barquisineto and Coro	Nov. 1, 1900	.. ..
Barcelona (Venezuela)-Ciudad (Bolivar)	Nov. 1, 1900	.. ..
Communication with Carthagena and Baranquilla	Dec. 8, 1900	.. ..
WEST INDIAN—Landlines to Baracoa, Guantago and Sagua de Tanamo	Nov. 12, 1900	.. ..
Landlines between Puerto Plata and San Domingo City	Nov. 20, 1900	.. ..
CHINESE—Tientsin-Pekin	June 11, 1900	.. ..
Pekin-Kalgan	June 14, 1900	.. ..
Kalgan-Maimatchin	June 30, 1900	.. ..
Tientsin, *via* Shanghai	June 16, 1900	.. ..
Tientsin and Taku *via* Helampo	June 18, 1900	.. ..
All lines connecting Cochin China with Thuanan	Oct. 23, 1900	.. ..
Communication between Saigon and North Annam and Tonkin	Oct. 23, 1900	.. ..
Communication "*via* Hanekine" interrupted on Persian territory	Feb. 26, 1900	.. ..

Telegraphs in Madagascar.—The Colonial authorities in Madagascar have succeeded in laying telegraphic communication a distance of 1,000 kilometres between the capital, Antananarivo, which lies 110 miles inland, and Diego Suarez, the most important military harbour of the island.

The Telephone in Germany.—The "Handels Museum" of the 13th ult. publishes statistics showing the development of the telephone system in Germany in 1899. These are given in the *Board of Trade Journal* as follows:—At the close of that year there were 12,710 telephone offices in Germany, as against 11,496 at the close of 1898. The number of telephone subscribers was 141,724 at the end of 1898, and 159,561 at the end of 1899, an increase of 12·6 per cent. The total number of conversations amounted to 574,000,000 in 1899, showing an increase of 51,000,000 or 9·8 per cent. over the number in 1898. The total number of employés was 6,724 at the end of last year, 4,527 of them being females. The receipts from the telephone service amounted to 30,405,061 marks in 1899, showing an increase of 17·1 per cent. over the receipts in 1898, which were 25,970,999 marks.

Tunbridge Wells Telephones.—The Corporation has so far secured 400 customers for its telephone exchange system. Communication was on Monday established with the public offices and institutions at Tunbridge.

Underground Telephones in Germany.—The *Daily Mail* Berlin correspondent says that the German telegraph authorities have made some successful experiments with the new subterranean telephone cables invented by the Rheydt Cableworks Company, and it has been decided to gradually replace the present overhead wire system with the new cables. The first line to be laid will be between Düsseldorf and Elberfeld, a distance of about 35 kilometres, the work to be begun in April. There are two other subterranean cables in Germany, between Berlin and Potsdam, and Cologne and Düsseldorf, but both failed to give satisfaction, repairs being frequently necessary and the cables unreliable. The Rheydt cable is said to give excellent results with greater economy.

CONTRACTS OPEN AND CLOSED.

OPEN.

Battersea.—February 1st. Tenders are wanted for ordinary and prepayment electricity meters. Consulting engineers, Messrs. Kennedy & Jenkin.

Canterbury.—January 30th. The Lighting Committee wants tenders for Lancashire boiler, 300-KW steam dynamo, piping, condensing plant, and switchboard extensions. See "Official Notices" to-day.

Colne.—January 19th. The Electrical Committee wants tenders for switchboard, balancer-booster, paper insulated mains, earthenware conduits, superheater, battery, ejector condenser, and motor pump. See "Official Notices" to-day.

Farnworth.—January 10th. The U.D.C. wants tenders for the supply of eight 66-passenger tramcar bodies, motors, undertrucks, controllers, &c. See "Official Notices" December 21st.

Fulham.—January 9th. The Borough Council wants tenders for certain materials and goods required for the electric light and dust destructor station. See "Official Notices" to-day.

Glasgow.—January 18th. The Corporation wants tenders for the supply of telephone apparatus in connection with the Pinkston tramways power station. See "Official Notices" December 28th.

Oldham.—January 29th. The Electricity Committee wants tenders for two 600-I.H.P and four 1,200-I.H.P. engines, each direct-coupled to a continuous current dynamo. See "Official Notices" to-day.

Paraguay.—January 15th. The municipality of Asomption, Paraguay, is inviting tenders for the electric lighting of the town. Bond £600.

Partick.—January 7th. The Commissioners want tenders for steam dynamos, battery charging motor booster and balancer. See "Official Notices" December 14th.

Poplar.—January 16th. The Borough Council wants tenders for an electric crane (maximum load 5 tons). See "Official Notices" December 28th.

Rathmines.—January 10th. The District Council wants tenders for Lancashire boiler, 300-KW. steam dynamo, condensing apparatus and pipework, switchboard extension, mains, and public lighting (incandescent). See "Official Notices" November 30th.

Rotherham.—January 19th. The Corporation wants tenders for the supply of a number of electricity meters. See "Official Notices" December 28th.

Sheffield.—January 21st. The Tramways Committee wants tenders for a slow speed vertical engine for driving a 1,000-KW. tramway generator. See "Official Notices" December 21st.

Southampton.—January 7th. The Corporation wants tenders for the overhead electrical equipment of 1¾ miles of tramway route. See "Official Notices" December 28th.

Southport.—January 21st. The Tramways Committee wants tenders for poles, brackets, bases, trolley wire, trolley wire attachments, galvanised steel wire, and section boxes for the tramways department. See "Official Notices" to-day.

Spain.—January 12th. The municipal authorities of Ayamonte (province of Huelva), are inviting tenders until January 12th for the concession for the electric lighting of the town during a period of 20 years. Tenders are to be sent to El Secretario del Ayuntamiento de Ayamonte (Huelva), whence particulars may be obtained.

Sunderland.—February 1st. The Corporation wants tenders for condensing plant and cooling tower, secondary battery, mains switchboard, and travelling crane for the electric light station. See "Official Notices" December 28th.

CLOSED.

Bristol.—The Electrical Committee has accepted the tender of Messrs. Bumstead & Chandler for induced draught plant.

Brighton.—Messrs. Macartney, McElroy & Co. are to construct permanent way, and carry out permanent way, wood paving, &c., for the Corporation at a cost of about £102,487.

France.—The French Ministry of Posts and Telegraphs in Paris has just placed contracts as follows:—Les Etablissements Mouchel, of Paris, 50 tons of copper wire 2½ mm. diameter, and 50 tons ditto 4 mm. diameter; La Compagnie Française des Metaux, 50 tons ditto 4 mm. diameter, and 50 tons 3 mm. diameter; Messrs. Lazare, Weiler & Co., 100 tons ditto 2½ mm. diameter, 50 tons ditto 3 mm. diameter and 50 tons ditto 4 mm. diameter; La Société d'Electro-Metallurgie 150 tons ditto 3 mm. diameter, and La

Compagnie du Bi-Metal, 50 tons ditto 4 mm. diameter. The prices range from 225 francs to 229½ francs per ton.

Southampton.—The Corporation has ordered six tramcars from the Westinghouse Company at £254 each, and bodies from Messrs. Milnes at £290 each.

FORTHCOMING EVENTS.

Wednesday, January 9th.—At 8 p.m. Institution of Electrical Engineers (Glasgow Section). Meeting at the Institution of Engineers and Shipbuilders, 207, Bath Street. "The Utilisation of water power for electrical purposes," By R. Frederick Yorke, member. (Illustrated by models.)

Thursday, January 10th.—At 8 p.m. Institution of Electrical Engineers. Meeting at the Institution of Civil Engineers. "Capacity in Alternate Current Working," by W. M. Mordey, member, and if time permit, "The use of Aluminium as an Electrical Conductor with new observations upon the Durability of Aluminium, and other metals under Atmospheric Exposure," by John B. C. Kershaw, F.I.C.

Friday, January 25th.—At 8 p.m. Institution of Junior Engineers. Meeting at Westminster Palace Hotel. Paper on "Railway Construction," by Mr. Alexander Ross, M.Inst.C.E., Engineer to the Great Northern Railway.

Saturday, January 26th.—The Institution of Electrical Engineers (Students' Section). Visit to the works of the India-rubber, Gutta-percha, and Telegraph Works, Company, Limited, Silvertown. Students desirous of participating in this visit must inform the Hon. Sec. of the Students' Committee before January 15th.

NOTES.

Obituary.—LORD ARMSTRONG.—The news of the death of Lord Armstrong at the ripe old age of 91 years, has been received in all parts of the British Empire with feelings of profound regret. In his earlier years he followed the practice of the law, but all the while his inclinations were scientific, and in time he abandoned law, and devoted his energies to the development of several of his inventions. For nigh half a century the art of gunnery was the main branch of research upon which his great genius was brought to bear; but hydraulic transmission of power and electrical engineering also owe much to the untiring efforts of Lord Armstrong. The wastefulness of the steam engine, and the coal supply question, were subjects upon which he held very decided views, as the following extract from the *Times* will show:—

> In the address he delivered as President of the British Association at Newcastle in 1863 he brought forward some calculations as to the amount of coal in our coalfields and the time it might be expected to last. He pointed out how rapidly we are consuming those seams from which coal can be taken of such a quality and at such a price as to enable us to maintain our supremacy in manufacturing industry. Were this coal being burnt in an economical manner no objection could be taken to the largeness of the quantities consumed. But the contrary is the case. In all applications—whether to steam engines or metallurgical operations or domestic purposes—it is wastefully and extravagantly used. Shortly after the delivery of this address the late Stanley Jevons's book on the coal question was published, and this was followed by the Royal Commission, of which Sir W. Armstrong was a member. The better utilisation of natural forces was a subject to which he again called attention in his presidential address to the mechanical science section of the Association at York in 1881, when he commented upon the "monstrous" wastefulness of the steam engine and discussed the question whether its difficulties might be avoided by resorting to electrical methods of obtaining power. Most people, he remarked, especially those least qualified to judge, look to electricity as the coming panacea for all mechanical deficiency; nevertheless, he himself founded a hope in the thermo-electric battery which, so far at least, shows no signs of being realised. That it was even more wasteful than the steam engine he acknowledged; but in view of its recent origin and our imperfect knowledge, he thought it not unreasonable to suppose that in time it would become of practical importance. For between the descriptions of an animal machine and an electro-dynamic engine actuated by thermo-electricity, he perceived a resemblance so close as to suggest that they may be regarded as substantially the same thing, though the animal is infinitely the more efficient of the two, working with heat of a low grade that is useless to the steam engine, and yet putting the latter to shame in respect to the amount of work it performs relatively to the fuel consumed. In thermo-electricity, too, he saw a possible means of utilising the heat of the sun as a motive power. With that source of energy we could afford to be wasteful. He calculated that the heat given off by the sun acting on one acre of ground in the tropics would, if fully realised, exert the amazing power of 4,000 horses for nearly nine hours every day.
>
> Lord Armstrong was the inventor of a form of electrical machine which at one time attracted a good deal of attention. The attendant of a high pressure boiler at a colliery near Newcastle happening to put one hand on a portion of the boiler while his other was exposed to a jet of steam that was issuing from a leak, experienced a smart shock. The phenomenon was investigated by Armstrong, the results of his inquiries being published in 1840 and the following years. On this discovery of the "electricity of effluent steam" he based the construction of his hydro-electric machine, which formed the most powerful means of generating electricity then known. It consisted essentially of an insulated boiler, from which steam at high pressure was allowed to escape through nozzles of peculiar construction. Faraday exhaustively examined the conditions under which electricity was produced in this apparatus, and the results obtainable by making the nozzles of different materials, and mixing various substances with the water. In later years Lord Armstrong will be remembered by visitors to the conversazione of the Royal Society (of which he became a Fellow in 1846) as an occasional exhibitor of electrical experiments, and it was in his 87th year that he published an elaborately illustrated book on "Electric Movement in Air and Water," which discussed and amplified a striking experiment he had performed more than half a century before.

Lord Armstrong had in his time occupied the presidential chairs of the Civils and the Mechanical Engineers. He was raised to the peerage in 1887 by Lord Salisbury. The enormous manufactories of Elswick are of world-wide repute, and they are a lasting monument to the scientific skill, energy and enterprise of one who was truthfully speaking one of the worthies of the nineteenth century.

The funeral of Lord Armstrong took place at Rothbury, Northumberland, on Tuesday afternoon. The remains were conveyed from Cragside on a draped car to the village churchyard, and were laid beside those of Lady Armstrong, who died about seven years ago. The under-bearers were chosen from representatives of the Cragside and Bamburgh tenantry, and of the Elswick, Cragside, Jesmond, and Bamburgh employés.

DR. W. POLE.—We regret to announce the death on Sunday last of Dr. William Pole, Mus. Doc., Oxon, the eminent civil engineer and musician, in the eighty-seventh year of his age. He was educated for a civil engineer, and, after following his profession in this country for some years, he was, in 1844, appointed by the old East India Company Professor of Civil Engineering in Elphinstone College, Bombay. He soon returned to his native land, and between 1859 and 1867 was Professor of Civil Engineering at University College, London, and Lecturer at the Royal Engineer Establishment at Chatham. He had a good reputation in his profession for his scientific attainments, and, on this account, he was frequently entrusted by the Government with important investigations and inquiries. Since June, 1861, he had been a Fellow of the Royal Society of London, and since 1877 of the Royal Society of Edinburgh. His life was an instance of the successful union of science, literature, and music. His taste for the divine art developed itself early; he studied hard at both theoretical and practical music, and was organist in a London West End church for many years. He was appointed Reporter to the Jury on Musical Instruments at the International Exhibition of 1862, and was one of the examiners for musical degrees in the University of London. He was the author of several works, one "The Philosophy of Music," and of various minor critical essays, but his only printed musical compositions are a well-known motet for eight voices on the "Hundredth Psalm," and some four-handed P.F. accompaniments to classical songs.

Lupus Light.—Lupus light is now being employed as a curative agent at the London Hospital. The Princess of Wales presented the first arc lamp several months ago, and since then, according to the *Pall Mall Gazette*, no fewer than 40 cures have been effected. It is stated that each arc lamp is of 35,000 C.P., and is worked by a dynamo stationed in an adjoining outhouse. There are at present two, and there are both space and need for another, for fully 140 patients are eagerly awaiting treatment.

False Teaching.—We are afraid that occasional confessions on the part of English electrical engineers that we are behind our foreign competitors have led some people to conceive an altogether exaggerated notion as to the extent of our backwardness. The *Daily Mail* is particularly pessimistic, and if one knew no better it would be excusable to imagine after reading some of its recent comments, that foreigners never come to poor old England for "dynamos, or electric tools, or electric lifts, or electric railway and tramway fittings." Whom does the writer mean when he speaks of "the foreigner"? It is beautifully indefinite. Is he aware of the fact that many other countries are now well able to manufacture whatever they require in the way of electrical machinery, and that for those who cannot do so English works are carrying out a share of contracts? We grant that the business has not been developed quite so much as it might have been, but in its attempt at brevity the *Mail* states but a half truth. Such a remark is bound to mislead, and it certainly can do no good. "Our streets are rarely lighted by electricity," adds the writer, overlooking the fact that we have well on for a couple of hundred electricity supply stations in operation from which public lighting supply is available whenever the local authorities see fit to adopt it, as they have already done in the majority of towns where stations are running. "As a motive power on our railways and tramways this new force has been as yet only occasionally employed, and the two or three electric railways of London are still a source of wonder to the inhabitants of our island." "Only occasionally" is, no doubt, a very convenient way to express it when you don't know the real position, but to-day we have about 60 electric tramway systems in operation, nearly all of which are extending, and perhaps it may be mentioned that these underground electric railways—"these sources of wonder" to English eyes, have more than once been also objects of very great interest to American and Continental engineers, who have paid them a visit to see how they were done and how best to copy them. This alone is sufficient to show that our contemporary goes unnecessarily out of its way to prove that our "competitors are ahead of us in the utilisation and application of electricity." However backward we may be, no improvement can be looked for from the erratic pessimism which sensational writers can produce. One thing is pretty certain, and that is, that the development now taking place throughout the kingdom in all branches of electrical application, is enormous. Perhaps the writer would like to know that the amount of capital invested in the electrical undertakings of the United Kingdom is given by Mr. Garcke as £123,636,000, independent of Government telegraphs and telephones, and we shouldn't wonder if that figure is doubled in the next 10 years.

A Curious Point of Law.—We hear of an extraordinary dispute which has arisen with regard to the occupation of a plot of land in the suburbs of London. It seems that the tenant of premises with a garden attached, was under covenant "not to carry on or permit to be carried on any trade or business on the said premises or any part of the same." Breach of this covenant was to involve forfeiture—subject, of course, to the law relating to forfeiture upon breach of covenant. The tenant, without thinking that he was doing anything amiss, permitted a telephone company to erect a pole in the back garden. We presume, although we have no definite information upon the point, that the company paid rent for this privilege. The landlord is now bringing an action of ejectment on the ground that the tenant has committed a breach of covenant in allowing a business to be carried on on part of the demised premises. We are not aware that this curious point has ever been raised before, which is strange when we remember the enormous number of telegraph poles that are erected on private property. Probably no one has considered it worth while to contest the point, as the amount of damage which such a user of premises is likely to do to the reversion is inconsiderable. In the absence of authority, it would seem that as a matter of strict law the tenant in such a case permits a business to be carried on, for without proper support for wires the telephone company would be unable to conduct their business. It will be interesting to learn what view the Court will take of this matter.

Wireless Fog Signalling at Sea.—Lights and lighthouses are of little use to protect ships from collision and shipwreck in case of dense fogs. Great expectations have been formed of the use of electric wave telegraphy for this purpose, and a trial recently made at Southend with a system devised by Colonel Hozier and Mr. Neville Maskelyne seems to justify these expectations. A transmitting station was established on shore near the danger point, and signals were sent out by an automatic apparatus, consisting of a revolving wheel, whose periphery is cut into teeth of varying size. This wheel takes the place of the operator at the Morse key, and transmits the name of the place in a series of dots and dashes in the Morse code. The wheel is driven by an electromotor or other convenient means, and it can be arranged to signal every minute or two, or continuously. Any vessel fitted with receiving apparatus coming within the range of the transmitter will be warned by the ringing of a bell, and will receive a Morse signal of the name of the transmitting station. In the trials at Southend the vessel was fitted with a vertical conductor, 50 to 60 feet in height, and the warning signal was received at a distance of seven to eight miles. No satisfactory method of indicating the direction of the source of radiation appears to have yet been devised. The range at which signals are received would, we imagine, be a very uncertain quantity, since it would vary widely with the sensitiveness of the receiver and the energy of the transmitter.

Cheap Gas.—In the next session of Parliament power is to be sought for the carrying out of a huge scheme for the manufacture and supply of fuel gas in the Midlands. Mond gas is produced from a cheap form of bituminous coal, or slack, suitable for use in large gas engines, which are now being manufactured in considerable numbers, and it is reported that experiments which have been made show that by means of power obtained in this way, electricity can be generated for less than one-twentieth of a penny per unit at the switchboard! The *Gas World* states that in the part of the Midlands in respect of which Parliamentary powers are sought, the charge for the gas is not to exceed 3d. per 1,000 cubic feet if the quantity taken per quarter is not less than 4,000,000 cubic feet, and that for smaller quantities than that the charge is not to exceed 4d. per 1,000 cubic feet. The gas is to be supplied for motive and heating purposes, "or for any other purpose to which such gas can be applied, but not for illumination." Even with this restriction, the introduction of this gas might make a big inroad on the business of the existing gas undertakings, and on that account it is likely to meet with strong opposition. The capital is set down at £1,000,000, while borrowing powers are asked to the extent of one-third of the paid-up capital.

Personal.—Mr. Thomas Scott, chief engineer to Messrs. Macartney, McElroy & Co., sails on Saturday, the 5th inst., per ss. *Umbria*, for New York, on business connected with the contract which that company has with the Durban Corporation for their electrical tramways. On his return from New York Mr. Scott will proceed to Durban, Natal, to carry out this contract and to open an office there for his company. Mr. J. Shepherd, one of the same company's engineers, also sails on the 4th inst. for Lisbon to superintend for Messrs Macartney, McElroy & Co. their contract for some 20 miles overhead construction with the Companhia Carris de Ferro de Lisboa.

Prof. William Ramsay, of University College, London, arrived at Bombay in December to advise in the organisation of the University of Research.

We hear that Mr. Philip Dawson, managing director of Robert W. Blackwell & Co., Limited, has just left for the United States, and that during his stay there he will, amongst other things, investigate most carefully the subject of electric traction on metropolitan and inter-urban lines.

Electromobiles Abandoned.—It is stated that the companies which placed 60 electric landaus on the streets of Paris just before the opening of the Exhibition, have decided to give them up. All sorts of accumulators were tried, but in every case the cost of the carriages was more than the receipts.

The Steam Turbine in Large Merchant Steamers.—Rear-Admiral George W. Melville, Engineer-in-Chief of the U.S. Navy, writes to the *Scientific American* to give his views on the steam turbine. He refers to the *Turbinia* and the *Viper*, and asks what value these vessels have. Are they not mere racing machines? He does not believe that the turbine has yet proved its value as a marine engine. It has, he says, done nothing that a reciprocating engine cannot do, while the reciprocating engine can do many things that the turbine cannot do. On this point, at any rate, we feel inclined to be in entire agreement with the Admiral. The reciprocating engine can do a lot that the turbine cannot do. The turbine cannot break its cross-head pin or split its connecting-rod head, and it cannot condense a fourth of the initial steam that enters it. Having said this, we may fairly agree that the turbine should be called on to run long-continued trips on service on wage-earning steamers before it can be fully admitted a member of the society of full-blown steam engines. Probably the Admiral's chief complaint is that the turbine runs so quickly as not to be very suitable for ordinary practice, and that special propellers have had to be invented or designed to suit it. But, *per se*, it does not follow that the new propeller need be worse than the old ones, and we believe that the gallant Admiral himself is responsible as much as anyone for multiplying the propellers on warships, for did he not put three on the *Columbia* with very good results? For electrical work, however, the author does appear to think it well suited as a driver of dynamos, and success is to be attained, it appears, at the hands of Mr. George Westinghouse, just as though it had not been pretty well proved by English engineers. Evidently the Admiral has not heard of the Halifax tramways, which are driven by a turbine, nor of a goodly number of lighting installations similarly equipped, nor of the two 1,000-kw. Parsons turbo-alternators recently supplied to the Elberfeld Corporation. In fact, the Admiral appears to think that the torpedo boats are failures, and are the only British examples of the turbine. While we believe in caution, we cannot think the worthy Admiral has given much study to the steam turbine.

The French Colonial Cables Scheme.—Yesterday's papers contain further details of the proposed French submarine telegraph cables. The *Standard* gives various details, too lengthy to publish this week. Dalziel's Paris correspondent, however, gives the matter briefly thus:—"A comprehensive scheme for an all-French cable, involving a first expenditure of 150,000,000 francs, is proposed in a private Bill about to be laid before the Chamber. The Bill is to be supported by 40 influential deputies, who are largely interested in Colonial questions. They claim that the scheme recently introduced by the Government does not go far enough, and urge that France can never feel secure in the development of her colonies until she owns telegraph lines of her own all over the world. The present scheme is for cables across the Atlantic and Indian Oceans, from the Levant and through the China Sea, with landlines through French West Africa, and along the coast of China. A second scheme proposes cables from Madagascar to Lourenco Marques, and from Saigon to Manila, at a further cost of 106,000,000 francs. The newspapers are sympathetic towards the scheme, but consider it too vast for France to undertake."

New Year Honours.—The Queen has conferred the honour of knighthood upon Mr. Hiram S. Maxim, and the dignity of a baronetcy upon Mr. John Aird, M.P. The engineering and electrical world will join us in our congratulations to the two eminent men, whose achievements have made them thoroughly worthy of the honours now conferred upon them.

Appointments Vacant.—The Manchester Electricity Committee is advertising for an electrical engineer at £800 per annum, and a deputy ditto at £500 per annum, for the electricity undertaking. The Manchester Tramways Committee wants a chief electrical engineer for the tramways department at £400 per annum. The Westminster Electric Supply Corporation wants an engineer to take charge of a watch. See "Official Notices" to-day.

The Lancaster Vacancy.—For the post of electrical engineer and electrical tramway manager there have been 34 applications. The majority of the applicants, however, objected to the arrangements whereby they had to be under the supervision of the borough engineer until the return of Mr. W. A. Fraser, the electrical engineer, who has been serving with the Middlesex Company of the Imperial Yeomanry in South Africa. The Corporation promised to keep his place open, and intend to let Mr. Fraser look after the electric light works, while the new engineer will ultimately devote his time to the new tramway scheme, which will cost £80,000. The Committee selected three gentlemen, whose ability will be the object of inquiry by a Sub-committee:—Mr. E. A. Browning, of the British Electric Traction Company, London; Mr. A. R. Dayson, assistant borough electrical engineer, Plymouth; Mr. W. A Tester, manager for the Western district of England for Messrs. Blackwell & Co.

The Pacific Cable.—A Sydney paper says that the T. C. & M. Co. undertook to lay this line by July 1st, 1902, if allowed to begin with the Fiji to Norfolk Island and Norfolk Island to Australia and New Zealand Sections, and finish with the Vancouver section.

Royal Society.—The Meteorological Council of the Royal Society has arranged with Mr. C. T. R. Wilson, F.R.S., for an investigation of certain phenomena connected with atmospheric electricity, and has obtained a grant of £200 for this purpose.

Birth of the Age of Electricity.—America's greeting to the New Century took the form of almost universal electrical illuminations, it being considered appropriate that the greatest scientific discovery of the dying period should inaugurate its successor.

The Underground and Electric Traction.—Mr. Forbes, chairman of the Metropolitan District Railway, has called upon shareholders to attend a meeting to be held on Monday for the purpose of arranging for the additional capital necessary for the electrical equipment of the line.

Institution of Electrical Engineers (Birmingham Section).—We are informed that the inaugural meeting of the Birmingham local section of the Institution of Electrical Engineers will be held in the buildings of the Birmingham University at 8 p.m., on Wednesday, January 23rd, when Dr. Oliver Lodge, the chairman of the section, will deliver his address. The president and secretary of the Institution have accepted an invitation to be present.

Correction.—A misprint occurred in Mr. Warrilow's article on "Water Loads" in our last issue; on p. 1012, line 26 from end of first column, for "lead to the rod," read "leak to the rod."

NEW COMPANIES REGISTERED.

Wolverhampton District Electric Tramways, Limited (68,345).—This company was registered on December 17th, with a capital of £200,000 in £5 shares, to carry on the business of carriers of passengers and goods, electrical engineers, electricians, engineers, contractors, railway, tramway, electrical and other apparatus manufacturers, producers and suppliers of light, heat and power, &c. The first subscribers (each with one share) are:—J. Devonshire, 2, Stafford Terrace, Phillimore Gardens, W., electrical engineer; J. Raworth, 2, Queen Anne's Gate, S.W., civil engineer; C. H. Dade, Donington House, Norfolk Street, W.C., secretary; G. J. Somerville, Surrey House, Victoria Embankment, W.C., electrical engineer; W. L. Madgen, Surrey House, Norfolk Street, W.C., gentleman; C. S. Hilton, Donington House, Norfolk Street, W.C., gentleman; and J. A. Lycett, Burnt Tree House, Tipton, Staffs., managing director. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £250; remuneration, £50 each per annum, and a share in the profits divisible.

Johnstone, Benjamin & Co., Limited (68,344).—This company was registered on December 17th, with a capital of £15,000 in £1 shares, to take over the business of electric wire and cable manufacturers and metal merchants now carried on at the

Crown Electric Works, Ascham Street, Kentish Town, N.W., by L. Benjamin and E. E. Benjamin, as Johnstone, Benjamin & Co., and to carry on the business of electricians, electrical and mechanical engineers, &c. The first subscribers (each with one share) are:—L. A. Somers, 40, Granville Gardens, W., auctioneer; R. Warner, 90, Listria Park, Stoke Newington, merchant; E. E. Benjamin, 4, Dovecote Villa, Wood Green, N., cable and wire manufacturer; L. Benjamin, 7, Mortimer Road, Kilburn, N.W., cable and wire manufacturer; J. Benjamin, 16, Petherton Road, N., traveller; F. Elesborne, 21, Turnpike Lane, N., fish merchant; and Mendelssohn, 56, Hilldrop Crescent, N.W., merchant. L. Benjamin and E. E. Benjamin are permanent managing directors. Registered office, 10, Ascham Street, Kentish Town, N.W.

Tangye Tool and Electric Company, Limited (68,342).—This company was registered on December 17th, with a capital of £100,000 in £1 shares, to acquire the business now carried on by Tangye's Machine Tool Company, Limited, to adopt an agreement with the said old company and W. J. Parkins, the proposed liquidator thereof, and to carry on the business of machine and other tool makers, founders, smiths, electrical and general engineers, electricians, motor car and cycle manufacturers, telephone, bell, phonograph, lamp and dynamo manufacturers, &c. The first subscribers (each with one share) are:—H. Tangye, Heathfield Hall, Handsworth, engineer; C. Tangye, Heathfield Hall, Handsworth, engineer; G. H. Haswell, Ashleigh, Hamstead Road, Handsworth, managing director; W. J. Parkins, 60, Murdock Road, Handsworth, secretary; W. R. Nicholl, Beechmount, St. Bernard's Road, Olton, accountant; W. Tangye, Heathfield Hall, Handsworth, engineer; and A. L. Tangye, 38, Old Jewry, E.C., solicitor. The number of directors is not to be less than three nor more than eight; the first are Sir R. Tangye (chairman), G. Tangye (vice-chairman), G. H. Haswell, H. L. Tangye and W. Tangye; each of the two first named may retain office so long as he holds £5,000 shares; ordinary qualification, £200. Registered office, Cornwall Works, Birmingham.

Richard Johnson & Nephew, Limited (68,402).—This company was registered on Dec. 19th, with a capitalof £200,000 in £10 shares (10,000 preference) to acquire and carry on the business now carried on at Bradford Iron Works, Manchester, and at Alderwasley, near Ambergate, Derbyshire, by H. A. Johnson and E. Johnson, under the style of "Richard Johnson & Nephew," and to carry on the business of ironmasters, wire drawers, galvanisers, iron and brass founders, steel converters, electrical, hydraulic, chemical and gas engineers, electric cable manufacturers, &c. The first subscribers (each with one preference share) are:—H. A. Johnson, Summerfield, Prestwich, Manchester, ironmaster; Mrs. A. Johnson, Oak Hurst, Alderwasley, Worksworth, Derbyshire; Mrs. E. A. Johnson, Summerfield, Prestwich, Manchester; H. M. Johnson, Northfield, Bury Old Road, Manchester, ironmaster; E. Johnson, Astle Cottage, Chelford, Chester, ironmonger; Mrs. V. S. Johnson, Castle Cottage, Chelford, Chester; L. A. T. Johnson, Sunnydene, Oxted, Surrey, gentleman; and A. Neill, Wyken, Broughton Park, Manchester, solicitor. Herbert A. Johnson and Ernest Johnson are permanent governing solicitors. Qualification, 5,000 shares.

Rheidol Mining Company, Limited (68,326).—This company was registered on December 15th, with a capital of £16,000 in £10 shares (800 preference), to acquire the "Rheidol Mine" and lands adjoining at or near Aberystwith, to adopt an agreement with A. B. Pescatore, and to carry on the business of silver lead, lead, copper and blend miners, electricians, founders, &c. The first subscribers (each with one share) are:—A. B. Pescatore, 16, Victoria Street, S.W., engineer; H. O. Tudor, Rosport, S. H. Luremberg, electrical engineer; T. Pescatore, 226, Burton Road, West Didsbury, Manchester, electrical engineer; E. Jacob, 64B, Hamilton Terrace, N.W., electrical engineer; F. Mather, 127, Clarence Road, Wimbledon, clerk to Tudor Accumulator Company, Limited; A. G. Soutter, 16, Prebend Gardens, Chiswick, W., draughtsman to Tudor Accumulator Company, Limited; and W. H. Stehr, 47, Harwood Road, Fulham, S.W., assistant draughtsman to Tudor Accumulator Company, Limited. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £200; remuneration, £300 per annum and a share in the profits divisible.

Ozonic Ventilating Company, Limited (68,382).—This company was registered on December 18th, with a capital of £3,000 in £1 shares, to carry on the business of ventilating, hydraulic, electrical, mechanical and general engineers, motor manufacturers, and makers of all appliances for ventilating, warming, cooling, extracting, disinfecting, and humidifying purposes, &c. The first subscribers (each with one share) are:—H. K. Luke, 12-14, Brazennose Street, Manchester, ironmonger; H. Kelley, 26, Pall Mall, Manchester, engineer; J. Boydell, 4, St. Anne's Square, Manchester, merchant tailor; J. Harvey, 110, Clarendon Road, Manley Park, Manchester; T. Guest, 92, Carruthers Street, Ancoats, Manchester, manufacturer; E. W. Donovan, Hilton House, Prestwich, engineer; W. Pearson, Church Road, Eccles, wine merchant; and C. H. Thompson, 40, Brazennose Street, Manchester, chartered accountant. Registered without articles of association. Registered office, Central Chambers, 40, Brazennose Street, Manchester.

Williamson & Joseph, Limited (68,448).—This company was registered on December 19th, with a capital of £4,000 in £1 shares, to acquire the business referred to in an agreement with the Consolidated Telephone Construction and Manufacturing Company, Limited, and to carry on the business of electricians, electrical and general engineers, suppliers of electricity, telegraph, telephone and electric light contractors, &c. The first subscribers (each with one share) are:—W. R. Brown, 523, Holloway Road, N., manufacturer; J. Harvey, 76, Murchison Road, Leyton, clerk; J. Clayton, 24, Birchin Lane, E.C., stationer; D. C. Shepherd, Ivydale, Baxter Avenue, Southend, gentleman; W. N. Tucker, 76, Birchanger Road, South Norwood, S.E., gentleman; F. C. Wimble, 93, Hambrough Road, Streatham, S.W., accountant; and F. C. Wilshere, Roslin, Church Walk, Thames Ditton, traveller. The number of directors is not to be less than three nor more than seven. The first are H. F. Jackson, C. Woolley, F. W. Kerr, and C. H. Reynolds; qualification, £100.

Electrical Transport and Power Company, Limited (68,412).—This company was registered on December 19th, with a capital of £10,000 in £10 shares, to apply for any provisional or other order or Act of Parliament to enable the syndicate to construct tramways or light railways and a bridge and works appurtenant thereto in the Island of South Hayling or elsewhere, and to carry on the business of tramway, light railway, ferry and bridge promoters, constructors and proprietors, electrical engineers, electricians, suppliers of electricity, &c. The first subscribers (each with one share) are:—J. W. Haynes, 59, Wanstead Park Road, Ilford, civil engineer; H. M. Hewitt, Tower Chambers, Brown Street, Manchester, engineer; T. Pollock, Goodear House, Hyde, engineer; J. P. Bedson, M.I.C.E., Newton House, Ryde; W. H. Watts, jun., 64, Brecknock Road, Camden Road, N.W., clerk; FitzGerald Arthur del Koosha, Teddington Park Road, Teddington, advertising agent; and E. Pember, 86, Brownlow Road, Dalston, N.E., clerk. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; qualification, £100.

St. Helens Electric Lighting Company, Limited (68,555).—This company was registered on December 21st, with a capital of £10,000 in £5 shares, to carry on the business of electrical engineers, electricians, practical engineers, contractors, mechanical and chemical engineers, &c. The first subscribers (each with one share) are:—F. E. Gripper, Broad Sanctuary Chambers, Westminster, S.W., electrical engineer; J. C. Wigham, Coanwood, Cranes Park Avenue, Surbiton, engineer; H. J. Read, Greenfield Villa, Liverpool Road, St. Albans; H. I. Butcher, Lancaster Road, New Barnet, clerk; L. A. Hards, Hampden Club, Phœnix Street, N.W., engineer; W. Christmas, 14, Marlboro' Road, Merton, Surrey, clerk; and G. F. Barrow, 45, Munster Square, N.W., clerk. The number of directors is not to be less than three nor more than seven; the first are to be appointed by the subscribers; qualification, 20 shares; remuneration as fixed by the company.

Crowther & Co.'s Electrical Industries, Limited (68,542).—This company was registered on December 31st, with a capital of £10,000 in £1 shares, to adopt an agreement for the acquisition of the business of Crowther & Co., electrical engineers and contractors, and to carry on the business of an electric supply company in all its branches. The first subscribers (each with one share) are:—E. R. Crowther, 5, Leaf Square, Pendleton, electrical engineer and contractor; C. A. Lickby, jun., The Acres, Bebington, Cheshire, electrical engineer; J. Stewart, 317, Great Cheetham Street East, Higher Broughton, Manchester, manager; M. Culverwell, 6, Albert Terrace, South Shore, Blackpool, contractor; C. A. de B. Copinger, Park Avenue, Alexandra Park, Manchester, electrical engineer; S. Saunders, The Limes, Hartington Road, Chorlton-cum-Hardy, heating engineer; and W. H. Whittaker, Deunebrook, Prestwich, Manchester, printer. E. P. Crowther is the first managing director. Registered office, 43, Lower Mosley Street, Manchester.

Promotion Syndicate, Limited (68,531).—This company was registered on December 21st, with a capital of £100 in £1 shares, to promote and register a company to be entitled "The Electrical Patents Developments Company." The first subscribers (each with one share) are:—L. Hill, 12, Theobalds Road, Holborn, W.C., valuer, &c.; J. Millard, 14, Hanover Cross, W.C., public-house manager; G. Harris, 22, Goodman's Yard, Minories, E., public-house manager; F. W. Wright, 14, Franciscan Road, Upper Tooting, S.W., gentleman; M. G. Warboys, 17, Long Acre, W.C., publican; H. W. Tredegar, 31, Great St. Andrew Street, W.C., publican; and F. H. Berry, 17, Long Acre, W.C., publican. Registered without articles of association. Registered office, 14A, Clerkenwell Green, E.C.

SUPPLY STATION ACCOUNTS.

Cheltenham Corporation Electricity Accounts.

THE accounts of the electricity department of the Cheltenham Corporation for 1899 show that the business is progressing favourably, but also that the financial charges are seriously affecting the net result of the year's working. The total capacity of plant installed reaches 800 KW. Public lighting is represented by 212 arc lamps of 16 to 18 amperes, and incandescents, one of 50 C.P., and 17 of 32 C.P. In

1898 there were 134 arc lamps and 13 incandescents. The proportion of units sold was as follows:—

Year.	Units generated.	Units to street lamps.	Units to private supply.
1898	507,830	192,712	183,122
1899	714,504	309,175	232,209

The sales to private consumers therefore account for a comparatively small portion of the increased output.

GENERAL STATEMENT.

	1898.	1899.	Increase.
Total capital expenditure ...	£75,125	**£90,839**	£15,714
Number of units sold	375,834	**541,384**	165,550
Maximum load in KW.	360	**450**	90
Gross revenue	£6,113	**£8,580**	£2,467
Gross expenditure...	£3,965	**£5,337**	£1,372
Gross profit	£2,148	**£3,243**	£1,095
Average price per unit sold ...	3·83d.	**3·64d.**	−·20d.

The gross revenue has more than doubled since 1897, when the total receipts stood at a little over £4,000. In the last year alone the increase has been nearly £2,500. The average price received for energy sold has fallen slightly, being now about 3¾d. per unit. The prices charged are from 3¾d. to 6d. per unit, on a sliding scale based on consumption per kilowatt maximum demand for private lighting; a special rate of 3d. per unit is in force for private supply for power and for the public incandescent lamps, while the somewhat curious annual rate of £19 10s. each per arc lamp for the first 150, £17 10s. each for the next 50, and £15 each for all in excess of 200 have been made. These are very low considering the local circumstances, and it may be thought that the policy of charging a higher rate and meeting all costs and liabilities would give rather greater satisfaction.

REVENUE STATEMENT.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase
Sale of current	£6,007	3·83d.	**£8,220**	3·64d.	−·19d.
Meter rents	2	·00d.	**3**	·00d.	·00d.
Sale of old material, &c. ..	104	·07d.	**357**	·16d.	+·09d.
Sundry fees	—	—	—	—	—
Gross revenue ...	£6,113	3·90d.	**£8,580**	3·80d.	−·10d.

We must congratulate Mr. Kilgour, the borough electrical engineer, upon reducing his coal bill below ¼d., and effecting a reduction as compared with 1898, in face of a high price per ton. The most marked change in the cost sheet occurs in the item for wages, which has fallen ·14d., and this, coupled with the reduced coal item, has brought down the works cost to a little over 2d. The changes in other items cancel out, allowing the reduction of ·17d. in the works cost to appear against total cost. In 1897 the total cost was 2¾d., so it is a good thing to have knocked off the fraction of ¼d., although, of course, the large increase being in street lighting, has tended to assist economical production.

COST OF PRODUCTION.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal	£1,322	·84d.	£1,790	**·79d.**	−·05d.
Oil, waste, water and engine room stores	269	·17d.	380	**·17d.**	·00d.
Salaries and wages incurred in generation and distribution and attending street lamps	1,316	·84d.	1,578	**·70d.**	−·14d.
Repairs and maintenance of buildings, engines, boilers, dynamos and public lamps, including carbons	538	·34d.	811	**·36d.**	+·02d.
Works cost ...	£3,435	2·19d.	£4,559	**2·02d.**	−·17d.
Rent, rates and taxes ..	152	·10d.	140	**·06d.**	−·04d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	236	·15d.	413	**·18d.**	+·03d.
General establishment charges, stationery and printing, law charges and insurance	142	·09d.	225	**·10d.**	+·01d
Other expenses	—	—	—	—	—
Total costs ...	£3,965	2·53d.	£5,337	**2·36d.**	−·17d.

The gross profit of £3,243 being only £1,095 in excess of 1898, when the financial charges aggregated £3,267, does not nearly meet the extra amounts put down for interest and sinking fund, which require an additional £1,483. The result is an increased loss of £388 (being the difference alluded to), and instead of £1,119 being the deficit, we now find the net loss appearing as £1,507. In 1898 the net loss was £300 less than in 1897, owing to an increase of £900 in gross profit and only £600 in repayments, &c. It seems fairly obvious, therefore, that the net revenue account can only be balanced by making the street lighting pay its proportion of the financial charges. These are, after all, really "costs" of the department.

PROFIT STATEMENT.

	1898.	1899.
Interest on loans	£1,650	£2,580
Sinking fund for repayments	1,617	2,170
Net profit carried forward	−1,119	−1,507
Gross profit	£2,148	£3,243

Dundee Corporation Electricity Accounts.

THE statement of accounts relating to the electrical department issued by the Dundee Gas Commissioners shows a remarkably successful position, and more than justifies the policy which has enabled the business to produce such results. The combination of gas and electricity is often unfortunate for the latter, but in this case the joint control has worked well. The capital is not only small, but it is being written off from profits, and a reserve fund has been created. Both output and maximum load are reaching more than mediocre figures, as will be seen. The capacity of the plant installed is, dynamos 683 KW., and batteries 248 KW.-hours.

GENERAL STATEMENT.

	1898.	1899.	Increase.
Total capital expenditure ...	£45,409	**£51,974***	£6,565
Number of units sold	451,942	**618,352**	166,410
Number of 30-watt lamps connected	27,966	**38,179**	10,213
Maximum load in KW.	623	**746**	123
Gross revenue	£7,267	**£9,044**	£1,777
Gross expenditure	£3,808	**£6,330**	£2,522
Gross profit	£3,459	**£2,714**	−£745
Average price per unit sold ...	3·86d.	**3·51d.**	−·35d.

* Of this sum £1,500 has been charged to revenue, leaving the net capital expenditure at £50,474.

The prices charged are on the discount principle, being 4d. per unit for up to 10,000 units yearly, and 3d. per unit for any larger consumption. Motive power is charged at 2d. per unit. A cash discount of 5 per cent. is given for payment within 28 days. The public lamps are debited at the rate of £16 10s. per annum. All these are moderate indeed, and the average gross return being only 3½d. per unit shows that in Dundee the municipal supply is given at a very favourable rate to the public. The revenue account is also noteworthy, as it only contains the one item of energy sold, the public are not called upon to pay meter rents, and sundry sources of revenue are apparently considered of little importance so long as the supply is taken up, all of which must tend to remove causes of friction between the department and the consumer.

There are now 50 500-watt street arc lamps, which in 1899 brought in £840 and consumed 88,081 units. On the other hand, 530,271 units were taken by private consumers, whose return (excluding bad debts and special discounts) was £8,595, or more than 10 times the sum obtained from public lighting.

REVENUE STATEMENT.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy	£7,267	3·86d.	**£9,044**	3·51d.	−·35d.
Meter rents, &c...	—	—	—	—	—
Sale of lamps, &c.	—	—	—	—	—
Sundry fees	—	—	—	—	—
Gross revenue ...	£7,267	3·86d.	**£9,044**	3·51d.	−·35d.

The costs given below are set out following the printed accounts, but it must be noted that against repairs is included the sum of £1,500, which, apparently, is a refund to capital. The total cost is therefore, shown at an inflated figure. Deducting the £1,500 in question, we get 1·24d. as the works cost, and 1·87d. as the total costs, the former being ·07d., and the latter ·15d., lower than in 1898. The repairs would then appear as ·05d. per unit, instead of ·63d., and the signs in the increase column would be reversed. But as only this £1,500 appears against repairs to mains, if it were discarded, the result would be that the mains cost nothing to maintain. The other items show reductions; save a small and trivial upward change in establishment charges.

COST OF PRODUCTION.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal and unloading same ..	£1,061	·56d.	£1,343	**·52d.**	−·04d.
Oil, waste, water and engine room stores.	219	·12d.	300	**·12d.**	·00d.
Salaries and wages incurred in generation and in distribution.	660	·35d.	706	**·27d.**	−·08d.
Repairs and maintenance of buildings, engines, boilers dynamos, and street lamps	519	·28d.	2,348	**·91d.**	+·63d.
Works costs	2,459	1·31d.	£4,697	**1·82d.**	+·51d

Rent, rates and taxes ..	744	·39d.	888	·34d.	−·05d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	482	·26d.	544	·21d.	−·05d.
General establishment charges, stationery and printing, law charges and insurance	123	·06d.	201	·08d.	+·02d.
Other expenses	—	—	—	—	—
Total costs ...	£3,808	2·02d.	£6,330	2·45d.	+·43d.

The financial charges have increased from £1,518 to £1,666, but this latter figure only represents ·65d. per unit, and as the gross profit works out at over 1d. per unit there is the equivalent of ⅔d. per unit or £1,048 as net profit. In 1898 the gross profit was considerably larger, as shown in the accounts, but if we take this £1,500 into the gross profit it will be apparent that it is really augmented by about £800. £1,000 has been placed to reserve fund, and the remainder available has been utilised with previous profits to wipe out some of the capital expenditure. Mr. Tittensor must be congratulated upon the whole of the figures.

PROFIT STATEMENT.

	1898.	1899.
Interest on loans, overdraft and deposits	£818	£966
Sinking fund for repayments	700	700
Net profit carried to reserve fund	—	1,000
" " expenses of loans	—	12
" repaid gas department	381	—
" carried to general surplus	1,560†	36
Gross profit	£3,459	£2,714

† This sum, together with monies derived from previous net profits, has been applied to pay one-third of the cost of extending the station.

CITY NOTES.

British Electric Street Tramways, Limited.

THE statutory meeting of this company was held on Monday last at the Hotel Cecil, Sir J. Kenneth Mackenzie, Bart., the chairman of the company, presiding. According to the *Financial News*, the CHAIRMAN admitted that the prospectus was of an unusual and somewhat florid character, but claimed that it was truthful. Pointing to the British Electric Traction Company, he said he did not see why this company should not be equally successful. Mr. Thos. Parker had consented to accept £300 instead of £500 per annum for his services as consulting engineer, and to forego the extra commission, equal to 10 per cent. of the dividends paid to the shareholders. "Mr. Parker," said the chairman, will "continue to act for the company in the same way as will Sir William Preece and Major Cardew (our consulting engineers and electricians)." The vendor company has agreed to allow the shares received as part payment of the purchase money to be deferred as regards dividends until 5 per cent. has been paid on the shares publicly subscribed for, and to allow £70,000 worth to remain in this company's hands, to be released as the remainder of the capital is issued. The chairman anticipated very profitable business in connection with projects now under consideration, and has connected himself with the largest of the new electric railway schemes solely in order to influence its being brought into the hands of this company.

Mr. LOCKYER read a letter from Major Cardew, addressed to the chairman, in which he denied that his firm had any official connection with the company; but the chairman stated that he had called on Major Cardew and come to an understanding with him.

Mr. GEDDIS moved a vote of thanks to Sir Kenneth Mackenzie, which was seconded by Mr. LOCKYER, and carried unanimously.

A statutory meeting of the Founders' Syndicate, Limited, was then held, but was merely formal.

Maxim Electrical and Engineering Export Company.

A REPORT of the second annual meeting of this company, held on Monday last at the offices, 65, Gracechurch Street, has been furnished to the financial press by the secretary. The chairman, Mr. Jules de Meray, after referring to the state of the engineering business for which the prospects are excellent, went on to explain the position of the lamp department. He said that they had shipped 6,368 lamps, but that number might have been largely increased if the Hiram S. Maxim Corporation had been ready. That corporation had been passing through a time of trouble inherent to the early stages of manufacture, consequent upon the education of a new staff of employés, and therefore the company ceased to push the lamp trade. These difficulties were now overcome, and the Hiram S. Maxim Corporation was prepared to give delivery of a very superior lamp. This company would therefore recommence to push that business. They had recently made independent tests which showed that the Maxim lamp was bound to command a large sale. Negotiations were proceeding with various agents and others for the sale of a large number of lamps. In addition to the incandescent lamp they had in active progess the production of an arc lamp which for price, efficiency and simplicity would beat anything else. It was a combination of two American and one English patents, and the company's emissary was now in the States arranging for the amalgamation of those patent rights, while some 1,500 lamps are in active manufacture in this country. About midsummer they expected to be able to put an arc lamp on the market that would be a potential revolution, and must secure the bulk of the arc lamp trade.

The Electric Lighting and Traction Company of Australia.

THE report of the directors to August 31st, 1900 reads:—The directors beg to submit the first balance-sheet and profit and loss account of the company for the period from August 17th, 1899, the date of the registration of the company, to August 31st, 1900. The profit and loss account shows an available net profit of £6,013 19s. 6d., and the directors recommend that this sum be applied as follows:—

To dividend on preference shares at the rate of 6 per cent. per annum from September 5th, 1899, to August 31st, 1900	£4,063 10 10
Balance carried forward	1,950 8 8
	£6,013 19 6

Melbourne.—Unexpected delay in securing the transfer of the properties and the orders in council belonging to the New Australian Electric Company, Limited, and the A. U. Alcock Electric Light and Motive Power Company, Limited, has been occasioned by the action of the Melbourne City Council and the Postmaster-General of Victoria. The directors have, however, recently received advice of the satisfactory settlement of all formal difficulties, and expect to obtain complete possession of the undertakings at an early date. In consequence of the above delay, the net revenue of the two Melbourne companies to which this company is entitled from January 1st, 1899, is not available as profit, pending final completion of purchase; and it will be seen that no credit is taken for such revenue in the profit and loss account. This revenue will, however, be available as profit so soon as the purchase is completed, and will be included in the accounts for the year ending August 31st, 1901. Meantime the business of the two Melbourne companies has continued to make satisfactory progress; and concentration of the generating machinery at the Richmond Station, and consequent administrative economies will follow promptly upon this company securing possession of the undertakings. Extended orders in Council for the supply of electricity in the important residential suburbs of Kew, Collingwood, South Melbourne, Malvern, Prahran, Fitzroy, Caulfield, Richmond, St. Kilda and Melbourne Harbour Trust, have been granted to the Melbourne companies; and in order to meet the large demand existing in these districts, orders for additional plant and mains have been placed, and some portion thereof has already been despatched. These extended orders run for a period of 25 years from September 6th, 1897.

Geelong.—The order in council for Geelong now stands transferred into the name of this company, and good progress has been made with the erection of a generating station upon a suitable freehold site, and the laying of distributing mains. It is expected that a regular supply of electricity will be available in the beginning of next year. This order runs for a period of 30 years from February 20th, 1899. Reports received from the company's engineers confirm the board in their belief that the undertaking at Geelong will prove remunerative.

Adelaide.—Since the formation of the company, the board have acquired the whole of the assets of the South Australian Electric Light and Motive Power Company, Limited, including a private Act of Parliament covering the Colony of South Australia, a small central station in operation at Port Adelaide, and the rights for electric lighting in the capital city of Adelaide. The station at Port Adelaide has, since it passed into the possession of this company, been extended, and is now earning an improving revenue, which, however, does not as yet balance expenses. At Adelaide, a suitable freehold plot of land has been purchased and substantial progress has been made towards completion of the works required for lighting the city, for which purpose the necessary plant has been ordered and partly shipped. It is hoped that this station will be completed during the spring or summer of 1901. The directors believe that the Adelaide undertaking will rapidly develop and prove a valuable investment. Owing to the rapid expansion of the company's undertakings at Melbourne, Geelong, and Adelaide, further capital will shortly be required for the purchase of additional plant and mains, and the matter is receiving the careful consideration of the board. The Stock Exchange appointed the March 21st, 1900, for the special settling day in the company's preference shares, and an official quotation for the same will no doubt be granted so soon as the purchase of the Melbourne properties has been finally completed. The auditors, Messrs. Cooper Bros. & Co., retire and offer themselves for re-election.

Stock Exchange Notices. — The Stock Exchange Committee has appointed special settling days as under:—Thursday, January 3rd, 1901, Kalgoorlie Electric Power and Lighting Corporation, Limited—150,000 6 per cent. cumulative preferred shares of £1 each, 10s. paid, Nos. 1 to 150,000. Marconi's Wireless Telegraph Company, Limited—77,083 shares of £1 each, fully paid, Nos. 1 to 40,000 and 100,001 to 137,083, and 60,000 vendors' shares of £1 each, fully paid, Nos. 40,001 to 100,000. Sir W. G. Armstrong,

Whitworth & Company, Limited—£750,000 4 per cent. first mortgage debentures of £100 each, Nos. 1 to 7,500 (registered).—Wednesday, January 9th, 1901, Blackheath and Greenwich District Electric Light Company, Limited—Provisional certificates for £100,000 4½ per cent. first debenture stock.—Tuesday, January 15th, 1901, London United Tramways, Limited—Provisional certificates for 328,744 4 per cent. first mortgage debenture stock, and has ordered these securities to be quoted in the Official List. Application has also been made to the Committee to appoint a special settling day in:—British Motor Traction Company, Limited—205,557 5 per cent cumulative preference shares of £1 each, fully paid, Nos. 1 to 205,557, and to allow the following securities to be quoted in the Official List:—Dick, Kerr & Company, Limited—24,000 5 per cent. cumulative preference shares of £5 each, fully paid.

Prospectus.—The prospectus of the Northwood Electric Light Company made its appearance last week. It has a share capital of £15,000 in £1 shares, and an issue of 10,000 ordinary shares is now being made by the directors, Messrs. J. S. Hignett, C. E. Masterman, J. W. Tilley, and D. S. Waterlow. The company has been formed to supply electricity for public and private lighting, and for motive power throughout the whole of the parish of Ruislip, which includes Northwood, and in a certain portion of the rural parish of Watford, on the low pressure continuous current system.

Rosling, Appleby & Fynn, Limited.—The warrants for the dividend on the 6 per cent. preference shares to December 31st, 1900, have been posted.

London Electric Omnibus Company.—This company was to have held its fourth ordinary general meeting on Monday for the purposes of adopting the directors' report, and deciding what to do in regard to the future of the company, but in view of the small attendance, and the fact that no proxies had been sent out, it was decided to adjourn the meeting until next Monday.

United River Plate Telephone Company, Limited.—The directors state that the business having continued to make satisfactory progress during the six months ended September 30th last, they feel justified in distributing an interim dividend for the period on the ordinary share capital at the rate of 5 per cent. per annum.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending December 21st were £441 4s. 7d.; corresponding week last year, £349 6s. 9d.; increase, £91 17s. 10d. Total to date, £22,572 7s. 11d.; corresponding period last year, £20,242 2s. 7d. Miles open, 1900, 8½; 1899, 8½.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending December 29th were £221; 8 days corresponding period last year, £213; increase, £8. Total to date, £20,385; corresponding period last year, £20,297; increase, £88.

Bristol Tramways and Carriage Company.—The receipts for the week ending December 28th were £4,969 15s. 9d.; corresponding period last year, £3,048 11s. 9d.; increase, £1,921 4s. 0d.

Central London Railway.—The receipts for the week ending December 29th were £4,911; previous week, £6,135; decrease, £1,224. Total receipts to date (22 weeks), £116,479. Miles open, 6.

City and South London Railway.—The receipts for the week ending December 30th were £1,704; corresponding week last year, £966; increase, £738. Total to date (half-year), £43,273; corresponding period last year, £25,982; increase, £17,291. Miles open, 1900, 4½; 1899, 3½.

Cork Electric Tramways and Lighting Company.—The receipts for the week ending December 27th were £450 9s. 1d.; corresponding week last year, £419 17s. 7d.; increase, £39 11s. 6d. Total to date, £21,198 9s. 4d.; corresponding period last year, £19,621 4s. 7d.; increase, £1,577 4s. 9d.

Dover Corporation Tramways.—The receipts for the week ending December 29th were £185 11s. 10d.; corresponding week last year, £158 2s. 0d.; increase, £27 9s. 10d. Total to date, £10,618 19s. 10½d.; corresponding period last year, £10,044 7s. 8d.; increase, £574 12s. 2½d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 4,169; 1899, 3,958. Number of cars, 1900, 11; 1899, 11.

Dublin United Tramways Company.—The receipts for the week ending December 28th were as follows:—D. U. T. Co., electric cars, £3,738 16s. 1d.; ditto, horse cars, £23 3s. 7d.; D. S. D. Co., electric cars, £816 14s. 4d.; total, £4,578 14s. 0d; corresponding week last year—D. U. T. Co., electric cars, £2,987 19s. 4d.; ditto, horse cars, £120 12s. 6d.; D. S. D. Co., electric cars, £664 16s. 10d.; total, £3,773 8s. 8d.; increase, £805 5s. 4d.; aggregate to date, £120,189 17s 0d.; aggregate to date last year, £107,082 1s. 7d.; increase, £13,107 15s. 5d. The mileage worked is 44 miles electrically, 1 mile by horses, as against 37 miles electrically, 7 miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending December 23rd were £1,516; corresponding week last year, £1,442; increase, £74. Total from July 1st, 1900, £41,174; ditto corresponding period last year, £40,250; increase, £824. Miles open, 6·57 chains. The receipts for the week ending December 30th were £1,397; corresponding week last year, £1,305; increase, £92. Total from July 1st, 1900, £42,571; ditto corresponding period last year, £41,665; increase, £916. Miles open, 6·57 chains.

STOCKS AND SHARES.

Wednesday Evening.

THE sensational batch of Stock Exchange failures coming at the end of a bad enough year would have put a crowning touch of misery to the financial world had it not been for the exuberant strength exhibited by the American railroad market. The two opposites—Westralian slump and Yankee boom—reacted upon the general markets so far favourably that no damage was done by the failures outside the department in which they occurred. So that what changes have taken place in quotations during the current week are very slight—in fact, were it not for the marking of quotations "*ex* div.," with the accompanying drop in prices, the fluctuations would be scarcely worthy of mention. Business is very quiet, the holidays still checking trade in the Stock Exchange, but there has been no forced liquidation of investment securities such as generally follows a crisis like that through which Capel Court has only just passed.

The London and Globe Finance Corporation, whose suspension of payment lies at the root of all the late Stock Exchange trouble, was the promoter of the Baker Street-Waterloo Railway. When the prospectus of that line made its appearance a couple of months ago we ventured to criticise its scheme in no measured terms, and very little attempt was made after allotment to keep up the fancy premium that was attached to the price of the shares when the company first made its *début*. Now those shares are practically unsaleable. It is known that the promoting house had to take a large number in payment of the purchase price, and waterlogged with these Baker Street and Waterloos, the Globe Company came crashing down, as it was unable to turn its hapless undertaking into ready money. No doubt we shall hear of the project again, but in the meantime the railway has the distinction of being one of the biggest white elephants in the City. Report has it that an American syndicate is offering £400,000 for the property.

The final settling day of the year is always marked by the deduction of Debenture dividend upon a very large number of stocks. In the Electric Supply Market, the Debenture stocks of the Chelsea, City of London, County of London, Metropolitan, and St. James's Companies are now quoted less the interest just paid, and the falls in the prices are virtually accounted for by the dividends. City of London 5 per cent. Debenture, however, is ½ per cent. lower. Some of the Preference share issues are hardening in anticipation of their dividend, Charing Cross 4½ per cents. more particularly. As regards the market in Ordinary shares, the only alteration is a slight advance in Westminsters. As the City of London Company distributes its dividends once a year—in March—the shares may be worth watching; an appreciation is not unlikely within the next two months, although its extent will probably not exceed £1 per share.

At the meeting of the British Electric Street Tramways Company on New Year's Eve, the chairman admitted that the prospectus may have been "florid" "and unusual in its tone." Beyond that he made no serious attempt to reply to the innumerable criticisms levelled at the company, nor did he refer to our searching *exposé* as to the way in which it had been evolved, contenting himself with sanguine optimisms and generalities concerning the future. He stated that public subscriptions had brought in nearly £70,000. Perhaps that accounts for the fact that there are only sellers to be met with in the market place of the Stock Exchange. At the meeting of the London Electric Omnibus on the same day, there was not a sufficient attendance to allow of a quorum being formed, so an adjournment was made until next week.

During the past year the new capital offered by electric lighting and electric traction companies for public subscription amounted to a shade under 5¼ millions sterling. This sum does not include vendors' shares. While it cannot be called large, the amount testifies to the steady way in which the electrical industries are going ahead, and seeing that a fair proportion of the total was in the shape of shares issued at premiums, it denotes good progress. To the 5¼ millions the last month of the year contributed £939,000, of which considerably more than half was due to the South Lancashire Electric Traction and Power Company.

The strength of the manufacturing section is the principal feature of the electrical markets this week. British Insulated Wire Preferred recovered their 3s. dividend at once, so did Callender's Preference, while the Ordinary shares of the Henley Company are 10s. better. India-Rubber shares, allowing for the 10s. deducted, are ¼ to the good. The Stock Exchange Committee indulged their imagination by quoting British Insulated Wire Ordinary *ex* dividend for a couple of days last week; they were only a month premature in their arrangements.

Darkness in the Twopenny Tube does not frighten the shareholders, who have been picking up the Deferred halves, the price of which is better again at 4½. The other electrical railway securities are unchanged in price. In the miscellaneous list, the National Telephones are better, some of their superfluous shares having been placed in strong hands by the market. Telegraph descriptions are exceedingly quiet, a slight advance in Eastern Extensions being the only change. It is said that China's acceptance of the Joint Note may be the signal of better times in the Far East, at all events, it has somewhat allayed the market's anxiety with regard to the telegraph companies operating in China.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Dec. 24th.	Closing Quotations Jan. 2nd.	Business done during week ended Jan. 2nd, 1901. Highest.	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —102 xd	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	85 — 90	85 — 90	...	...
822,700	Anglo-American Telegraph	Stock	3 %	£3 9s.	73/6	52 — 55	52 — 55	...	...
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	97 — 99	97 — 99	98½	97½
3,088,540	Do. do. Deferred	Stock	...	18s. %	£1 7s.	10 — 10½	10 — 10½	10⅜	10 5/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	4 %	3 — 3½	3 — 3½	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	170 —180	170 —180 xd	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	101 —103 xd	103½	102⅜
16,000	Cuba Telegraph	10	7 %	8 %	7 %	6½— 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	15 — 16	15 — 16	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100-104%xd	...	...
60,710£	Direct United States Cable	20	3¼%	3½%	3 %	10 — 10½	10 — 10½	10 7/16	10 5/16
108,300	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	98 —101 xd	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	136 —141	136 —141	139	136
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	96 — 99	96 — 99	98	96
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	110 —114	110 —114	110½	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	13¾— 14¼	14 — 14½	14 5/16	13⅞
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) £8 pd.	10	...	...	...	9¼— 9¾	11¼— 11¾	9⅜	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	113 —118	113 —118	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	...	..
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	99 —102%	99 —102%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5½%	5½%	10½— 10¾	10½— 10¾	10½	...
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15 — 15½	15 — 15½	15 7/16	15 5/16
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	12½%	...	31 — 33	30 — 32	...	...
82,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	98 —101 xd	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	48 — 52	48 — 52	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	104 —107	104 —107	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	2½%	¼— ⅝	¼— ⅛	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	4 %	5 %	⅜— 1	⅜— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	6 %	5 %	4⅛— 4⅜	4⅛— 4½	4½	4⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	12⅞	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5 — 5¼	5 — 5¼	5	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	96 — 99	94 — 97 xd	...	...
500,000	Do. 4 % Deb. Stock Red.	100	...	...	...	101 —104	99 —102 xd	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	101 —104	99 —102 xd	101½	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	123 —128	123 —128	...	...
58,000	United River Plate Telephone	5	5 %	6 %	7 %	4½— 5	4½— 5 xd	...	...
16,639	Do. do. 5 % Cum. pref. Nos. 1—16,639	5	...	...	...	5 — 5½	4⅝— 5½xd	...	...
23,361	Do. do. Nos. 16,640 to 40,000 £3½ pd.	5	...	...	...	3½— 3⅝	4¼— 5½xd	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	102 —105	...	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	100 —103	99 —102 xd	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	7 %	14 — 14½	13⅝— 14¼	14 1/16	13⅞
75,000	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	103 —106	100 —103 xd	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	103 —106	103 —106 xd	...	...
88,321	West India and Panama Telegraph	10	¾%	2 %	⅝%	⅝— ⅞	⅝— ⅞	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	6 — 7	6 — 7	6 1/16	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	5 — 7	5 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	105 —108	105 —108 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

12,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref....	5	7 %	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	9½— 10½	9½— 10½	9⅝	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 6	5½— 5⅝	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	6 %	6½— 7	6½— 7	...	...
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	4½%	...	...	111 —114	109 —112 xd	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	10 %	6 %	4 %	9 — 10	9 — 10	9⅝	9⅜
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	13 — 14	13 — 14	13 5/16	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	125 —130	122 —127 xd	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	4 %	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11½— 12½	11½— 12½	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	108 —111	106 —109 xd	108	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	103 —106	103 —106	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 2	1½— 2	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	6 %	...	4 — 5	4 — 5	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101 xd	98 —101	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	12 — 13	12 — 13	12⅝	12½
220,000£	Do. 4½% First Mortgage Debenture Stock	...	4½%	...	...	112 —115	110 —113 xd	...	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	98 —101	96 — 99 xd	...	...
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	14½— 15½	14½— 15½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15 — 16	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	100 —103	98 —101 xd	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	2	...
50,000	Do. do. 4 % Deb.	100	...	...	...	85 — 95	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	12 %	13 %	12 — 13	12½— 13½	...	...

* Subject to Founders Shares. Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Dec. 24th.	Closing Quotation Jan. 2nd	Business done week ended Jan. 2nd, 1901. Highest	Lowest
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	8½ — 9½	8½ — 9½	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	...	6 %	...	13½ — 14½	13 — 14	13⅜	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12⅝	12½
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	120 —123	121¾	121
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	½ — ⅝	½ — ⅝	...	...
50,000	† Do do. 6 % Cum. Pref., 1—50,000 ...	...	...	...	...	⅝ — ⅞	⅝ — ⅞	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	97 — 99	97 — 99	...	...
70,000	British Insulated Wire Ord.	5	15 %	15 %	20 %	11 — 12	10½ — 11½	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅜ — 6¼	5⅜ — 6¼xd	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	3 %	5 %	6 %	1⅜ — 1⅝	1⅜ — 1⅝	1 1⅜/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	6 %	2 — 2¼	2 — 2¼	2¼	2 3/16
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	106 —111	106 —111	...	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	103 —105	101 —103 xd	102½	102
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	12½%	15 %	15 %	12½ — 13½	12½ — 13½	...	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5¼ — 5⅜	5¼ — 5⅜xd	5½	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	S ock	...	...	...	111 —115	109 —113 xd	...	...
206,297	Central London Railway, Ord. Shares	10	...	...	...	9¼ — 9⅜	9¼ — 9⅜	9⅝	9⅜
78,703	Do. do. Pref. half-shares	5	...	...	...	4⅜ — 5¼	4⅜ — 5¼	5⅛	5
78,703	Do. do. Def. do.	5	...	...	...	4 — 4½	4 — 4½	...	...
855,000	City and South London Railway	Stock	1⅞%	2⅛%	1⅞%	52 — 56	52 — 56	54	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	4½ — 5½	4½ — 5½	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	...	6 %	7½%	3½ — 4	3½ — 4	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —102	98 —101 xd	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	6 %	1⅞ — 2¼	1⅞ — 2¼	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	6 %	3¼ — 4½	3¼ — 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	90 — 92	88 — 90 xd	...	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	96 —100	96 —100	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	2 — 2¼	2 — 2¼	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	7 %	...	2⅜ — 3½	2⅜ — 3½	...	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	102 —105	103 —106	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	7 %	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	12½ — 13½	13 — 14	13⅜	13
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5¼ — 5⅜	5¼ — 5⅜	5⅜	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	...	...	108 —112	108 —112	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	20½ — 21½	21¼	...
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	3⅜%	8⅝ — 8⅞	8⅜ — 8⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5	13½ — 13⅝	13½ — 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	38 — 42	38 — 42	41	40
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...%	101 —104	100 —103 xd	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	10 — 11	10 — 11	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5¼ — 5⅜	5¼ — 5⅜	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	94 — 97	94 — 97	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 103—106.
Consolidated Telephone Construction and Maintenance, 3/—5/-
National Electric Free Wiring, 12/6 paid, ⅛—¼.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16—17.
Do. do. Pref. (£10 pd.), 10—10½.
* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 11½—12½; 1st Preference Cumulative 6 % £5 (fully paid), 6½—7½. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 16½.

Bank rate of discount 4 per cent. (July 19th, 1900).

MARKET QUOTATIONS, Wednesday, January 2nd.

CHEMICALS, &c.		This week.	Dec. 19th.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3¾d.	3¾d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..
METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £145	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	9d.	8d.	..
c ,, Wire, basis	per lb.	8½d.	8½d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c ,, ,, (solid drawn) ..	per lb.	10¾d.	10¾d.	..
g Copper Bars (best selected) ..	per ton	£86	£86	..

METALS, &c. *(continued.)*		This week.	Dec. 19th.	Inc. or Dec.
g Copper Sheet	per ton	£86	£86	..
g ,, Rod	per ton	£86	£86	..
c ,, (Electrolytic) Bars ..	per ton	£82	£82	..
c ,, ,, Sheets ..	per ton	£90	£90	..
c ,, ,, Rod ..	per ton	£84	£84	..
c ,, ,, H.C. Wire	per lb.	9½d.	9½d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/9½ to 3/10½	3/10½	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	52/9	52/9	..
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£10 15	£11 10	15s. dec.
g Lead, English Ingot	per ton	£16 5 to £16 7 6	£16 5 to £16 7 6	..
g ,, ,, Sheet	per ton	£19	£19	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£3 18	£3 18	..
p Silicium Bronze Wire	per lb.	10½d. to 1/3	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£126 to £127	£120 to £121	£6 inc.
g ,, foil	per lb.	2/-	2/-	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9½d.	9½d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	5¾d.	½d. inc.
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4½d.	4¼d.	¼d. inc.
j ,, ,, Russian, 10 lbs. ..	per lb.	5¾d.	5½d.	¼d. inc.
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne ond.)	per ton	£23 2 6	£23 2 6	..

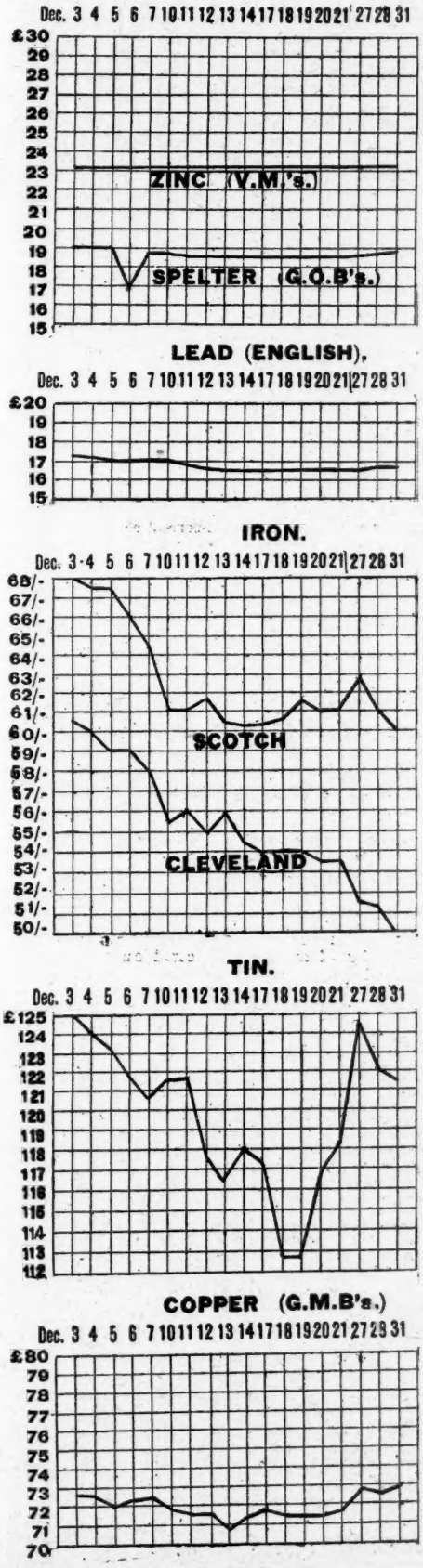
Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd

METAL MARKET.

Fluctuations in December, 1900.



INSTITUTION OF ELECTRICAL ENGINEERS.

ON RAPID VARIATIONS IN THE CURRENT THROUGH THE DIRECT-CURRENT ARC.

By W. Duddell, Wh. Sc., Associate.

(*Paper read December 13th*, 1900.)

(*Concluded from page* 1040, *Vol.* 47.)

With cored carbon electrodes the arc under similar conditions could not be extinguished by shunting with 5·4 mf., so that since the initial steepness of the curve B was $\frac{1}{3}$th, or about 7×10^5 volts per second, this curve always intersected the curve A for cored carbons. Further, I think that the curves would still intersect, that is, the cored arc would relight, if the initial steepness of B had been even many times smaller, so that the rate of increase of apparent resistance of the cored arc after interruption of the current is many times smaller than with the copper arc. In what has been said above, I have neglected the unknown self-induction of the leads, so that the figures given must be considered as only rough approximations.

The extreme rapidity with which it is necessary to increase the P.D. between the terminals of the metal arc in order that it may relight again after the current through it has been stopped, explains the fact that it seems impossible to maintain an *alternate* current arc between *metal* electrodes at ordinary frequencies and P.Ds. of even several hundred volts; and that it requires a P.D. as high as 2,000 volts to maintain a metal arc as found by Herr Arons.*

If the non-inductive resistance in series with the arc be replaced by a highly inductive one as shown in fig. 11, the curve B will be altered in shape, and with the conditions inserted under fig. 11 the charge of the condenser will be oscillatory as shown by B′ fig. 10, the maximum P.D. attained if the arc fails to relight at all being many times as high as the E.M.F. of the source of supply. Although the arc is put out on shunting with a condenser, it does not follow that it may not have really relit and gone out again several times corresponding with each swing of the condenser, before it is finally left extinguished owing to the dying away of the oscillations; and this is probably what occurs when the curve A is not very steep, as in the case of cored carbons. In this case the maximum rise in P.D. will be limited by the shape of the curve A and by the amplitude of the oscillations being rapidly damped, due to conduction through the arc.

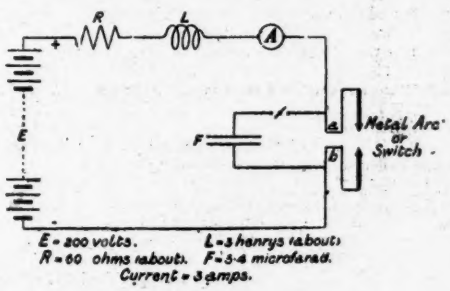


Fig. 11.

This high rise in P.D.—caused by the sudden annulling of the current through the self-induction when the metal arc is extinguished on shunting it with a condenser—is very serious, as the following experiment shows. A 3-ampere arc between two copper electrodes 6 mm. diameter, the conditions of the circuit being those given under fig. 10, was shunted with a condenser 5·4 mf. capacity. This caused the arc to go out and so high a rise in P.D., to be produced that the insulation of the leads broke down, a spark passing from *a* to *b*, accompanied by a report. [Experiment.] When, however, I substituted carbons for the copper electrodes, no report was heard, nor was any serious rise in P.D. noticed. [Experiment.]

The next experiment tried was to connect the condenser permanently as a shunt to the metal electrodes, and then to attempt to strike the arc, the circuit being arranged as in fig. 11. I found that it was impossible to strike an arc between metal (Cu., Fe., Al., and brass) electrodes if the capacity of the condenser F, fig. 11, exceeded 0·1 mf.—even although an E.M.F. of 200 volts was used—and that on separating the electrodes the sudden interruption of the current through the self-induction set up oscillations in the circuit and a high rise in P.D. between the terminals of the condenser similar to that produced when the metal arc was extinguished by shunting with a condenser as explained above. The condition that determines the possibility of striking the arc is similar to the condition that governs the relighting of the arc after the current through it has been reduced to zero as explained above. For corresponding with each position of the electrodes as they separate there is a certain P.D. required to start the arc, and if the relation between the position of the electrodes and time be known, then a curve between P.D. required to start the arc and time can be plotted similar to curve A, fig. 10 above, and the intersection or otherwise of this curve with the curve B′ determines whether the arc will strike or not.

* *Wiedemann's Annalen*, Vol. lvii., p. 185

The practical interest in this subject of the striking of the arc lies in the fact that when the attempt is made to interrupt a steady direct current flowing through an inductive circuit by means of a switch with metal contacts, an attempt is really made, at the first instant, to strike a metal arc between the contacts, and if these contacts be shunted by a condenser which prevents the arc from forming, a high rise in P.D. will occur. If, however, the arc was allowed to form, the time during which the break takes place would be lengthened, and no such great rise of P.D. would be produced. This rise in P.D. has been mathematically investigated by Mr. Johnson* on the assumption that the arc does not form, and putting the data given under fig. 11 into his equation, I find that the rise in P.D. is just over 2,000 volts, as compared with 200 volts, the E.M.F. in the circuit. It is, therefore, of importance when it is required to prevent these rises in P.D., on breaking the circuit to so choose the substance of the switch contacts that the arc shall not be prevented from forming or be suddenly extinguished by the action of the condenser, that is to say, *that arcing at the switch contacts should rather be encouraged than otherwise*, of course always supposing that no special method such as a non-inductive resistance shunting the switch be provided to dissipate the energy stored in the self-induction.

The following experiments illustrate the importance of the nature of the switch contacts and of the condenser which shunts them. The circuit used was that shown in fig. 11, the arc being replaced by a switch with brass contacts, and the data of the circuit being those given below the figure. When the condenser F was disconnected, and the insulation between *a* and *b* was made to consist of a single thickness of paper, I found that the circuit might be made and broken by means of the switch, either quickly or slowly, without the paper between *a* and *b* being pierced. [Experiment.] After reconnecting the condenser F, however, every time the switch was opened the paper was pierced, and even three thicknesses of the paper could not withstand the rise in P.D. that occurred. [Experiment.] The steady P.D. required to pierce one thickness of the paper was found by a separate experiment to be about 550 volts, and that required to pierce three thicknesses about 1,500 volts, so that without the condenser shunting the switch the rise in P.D. on breaking the inductive circuit was under 500 volts, but with the condenser as a shunt to the switch was over 1,500 volts, showing that the metal arc must have been almost completely suppressed, as the maximum value of the P.D. calculated above on the assumption of no arc forming at all was only just over 2,000 volts.

The influence of the nature of the contacts of the switch on the rise in P.D. which occurs when the switch is shunted by a condenser is very marked; thus with the metals, copper and brass, serious rises in P.D. were always found to occur, with solid carbons as contacts the rise was much less, and with cored carbon contacts was inappreciable. [Experiment.]

Breaking the circuit between metal contacts under tap-water, or shunting the metal contacts while in air by wires dipping into water, also prevented any serious rise in P.D.

It was also found that resistance or self-induction introduced into the connections between the condenser and the contacts greatly reduced the rise in P.D. on opening the switch.

I attempted to use an electrostatic voltmeter to measure the rise in P.D. instead of the rough method of the piercing of paper, but although the voltmeter was sufficiently sensitive to read steady P.Ds. much below that required to pierce the paper, it failed to indicate the rises in P.D. This is probably due to the short time the rise in P.D. lasts.

There are two practical cases in which capacity shunts the switch contacts to which I will refer.

The first is the ordinary induction coil in which the circuit is the same as fig. 11, the switch being replaced by the contact maker. In this case a high rise in P.D. is required so that the nature of the contact points should be such that the arc can be completely extinguished by as small a condenser as possible; for the rise in P.D., if the arc is completely extinguished, will be the higher the smaller the capacity of the condenser. It is evident, therefore, that carbon would be very unsuitable for the contacts of an induction coil. This has lately been shown to be the case by the experiments of Mr. Beattie,† who finds that with a slow break the maximum length of spark obtainable between the terminals of the secondary, using *platinum contacts*, is nearly 2½ times that obtainable when *carbon contacts* are used, the current interrupted at the break being the same in both cases. I think that if *cored carbons* had been used, a much greater disparity in the spark length would have been found. [Experiment.]

The second case is that of a switch or circuit breaker connected with a concentric cable so that the capacity shunting the contacts is supplied by the distributed capacity of the cable. Whether this distributed capacity in practical cases will have the same effect as a condenser shunting the contacts, as suggested by Mr. Johnson, is, I think, a matter for further experiment. If it has, then serious rises in P.D. are to be apprehended on interrupting a *direct* current, through an inductive circuit, by means of metal contacts, the capacity of the cable forming a shunt to the contacts.

Assuming this to be true for *direct* currents, may not some of the breakdowns of concentric cables supplying power by means of *alternating* current be also due to the sudden quenching of the arc at metal contacts, and not to the fact that the current is an alternating one? I suppose, of course, that the attempt to interrupt the current is made at some point in the period when the current is large.

Before concluding this paper, I wish to express my indebtedness to Prof. Ayrton and Mr. Mather, of the Central Technical College, not only for allowing me to carry out the experiments in the laboratories of the College, but also for the valuable assistance and advice they have given me during the course of the experiments. I also wish to express my thanks to the many students who have helped me from time to time, and especially to Messrs. Brown, Watson, and Fithian.

* The *Electrician*, 1900, Vol. xlv., p. 281.
† *Phil. Mag.*, 1900, Vol. l., p. 146.

Conclusions.—If the current be suddenly increased through a direct-current arc between two solid carbons, the P.D. and current increase together for less than about $\frac{1}{5000}$ second, and at the end of this very short time the P.D. decreases with an increase of current in the ordinary way.

If the current through a direct-current arc varies by as little as 3 per cent. from the mean, and if the frequency of these superimposed variations is even as high as 4,300 ~ per second, a variation in the light emitted by both the + crater and the vapour column can be detected.

A rapid periodic variation of the order of one part in 10,000 from the mean current will alter the vapour column of the arc sufficiently to produce sound-waves; and a variation of one part in 100 will produce sound-waves even at frequencies as high as 30,000 ~ per second.

The arc is affected by such small changes of outside conditions as sound-waves produce.

The direct-current arc can be used both as a telephone receiver and transmitter.

In the direct-current humming arc the P.D. current and light emitted vary periodically, the frequency of these variations being the same as that of the rotation of the arc as a whole, and of the pitch of the sound emitted.

In the direct-current hissing arc the P.D. current and light emitted vary very irregularly, the larger and slower variations corresponding with a rotation of the arc as a whole and the smaller and more rapid to the hissing proper, *i.e.*, the oxygen of the air obtaining access to the crater surface as demonstrated by Mrs. Ayrton.

Under certain conditions the direct-current solid arc will emit a musical note when shunted by a self-induction in series with a condenser.

When emitting the musical note, the direct-current arc transforms direct-current energy into alternate-current energy, the frequency of the latter being determined by the self-induction, capacity, and effective resistance of the oscillating circuit. The pitch of the note emitted may be used as a means of comparing self-inductions and capacities.

If a direct-current arc be shunted with a condenser of several microfarads capacity, the arc will generally be extinguished if the electrodes are of metal, and not if they are of cored carbon, the resistance in series with the arc being non-inductive.

If the resistance in series with the arc be highly inductive, then, when the metal arc is extinguished by shunting it with a condenser, a violent rise in P.D. occurs between the terminals of the arc.

The rise in P.D. that occurs when an inductive circuit is broken by means of a switch, the contacts of which are shunted by a condenser, is much higher if their contacts are of metal than if they are of cored carbons, owing to the condenser extinguishing the metal arc formed at the contacts more suddenly than the arc formed when carbon contacts are separated.

APPENDIX I.

On the Resistance of the Cores of Cored Carbons.

I do not remember having seen it pointed out that the much greater stability of arcs between cored carbons than of those between solid carbons can not be very well due to the high conductivity of the material of the core, while in place in the carbon, for the cores have generally a higher specific resistance than the solid carbon which surrounds them, as the following experiment shows:—

Three carbons were taken—two cored and one solid—of the same nominal diameter (11 mm.), and a current of 9·9 amperes was passed through them. The drop of volts was measured along a length of 20 cms. of each after they had attained a steady temperature.

Each of the three carbons then had a hole 3·16 mm. diameter drilled through it so as to completely remove the cores of the cored carbons and the centre of the solid carbon, and the drop of volts was remeasured as before. The results are given in the table below, from which it appears that drilling a hole in the solid carbon increased its resistance 7·8 per cent., whereas drilling the same sized hole (which removed the core and a small amount of the solid carbon) in a cored carbon of the same make only increased its resistance by 2·1 per cent.

Allowing for the fact that a small quantity of solid carbon was removed along with the core in drilling, *the specific resistance of the core, of one make of cored carbon, was about* 16 *times that of the surrounding solid carbon, and in the other the specific resistance of the core was practically infinite.*

Make of carbons	"Apostle" *Solid.*	"Apostle" *Cored.*	"Brush" *Cored.*
	mm.	mm.	mm.
Mean diameter	10·97	10·95	10·70
Mean diameter of core	—	2·84	2·82
Drop of volts along 20 cms. *before* drilling ..	1·71	1·74	1·52
Drop of volts along 20 cms. *after* drilling ..	1·84	1·77	1·56
Per cent. increase of resistance due to drilling	7·8	2·1	2·4
Ratio $\frac{\text{Specific resistance of core}}{\text{Specific resistance of surrounding solid carbon}}$	about	∝	16

APPENDIX II.

On the Conditions which Govern the Conversion of Direct Current into Alternating Current in the Musical Arc.

(See Fig. 9.)

Let E and C be the E.M.F. and current through the cells, when there is no oscillatory current through the condenser circuit.

Let V and A be the P.D. and current through the arc under the same conditions.

Let R be the resistance in series with the arc, including that of the cells.

Let r be the resistance of the condenser circuit.

Let δv be a small change in the P.D. arc which produces a current δi through the condenser circuit for a time δt, and let δv and consequently δi be assumed to change sign at the end of each interval of time δt.

Let δA and δC be the corresponding changes in A and C; R being assumed constant.

The energy supplied to the condenser circuit—

during one interval $\delta t = (v + \delta v)(+\delta i)\,\delta t$

„ next „ $\delta t = (v - \delta v)(-\delta i)\,\delta t$

Total during one complete period $2\,\delta t = 2\,\delta i\,\delta v\,\delta t$

Energy dissipated in ohmic losses during $2\,\delta t = r\,(\delta i)^2\,2\,\delta t$.

In order that, during each complete period $2\,\delta t$, energy may be supplied to the condenser circuit, we must have

$\delta i\,\delta v$ positive.

And in order that this supply shall make up for the ohmic losses we must have

$$\delta i\,\delta v \geq r\,(\delta i)^2$$

Now

$$\delta i - \delta C = \delta A$$

and

$$C = \frac{E - V}{R}$$

$$\therefore \delta C = \frac{-\delta v}{R}$$

and

$$\delta i = -\frac{\delta v}{R} - \delta A = -\left(\frac{1}{R} + \frac{\delta A}{\delta v}\right)\delta v$$

$$\delta i\,\delta v = -\left(\frac{1}{R} + \frac{\delta A}{\delta v}\right)(\delta v)^2$$

$\therefore$ for a supply of energy to condenser circuit $\frac{\delta v}{\delta A}$ must be negative and numerically less than R.

Supposing $\frac{\delta v}{\delta A}$ negative, then in practice the second condition is always fulfilled, or $\frac{\delta v}{\delta A} + R$ would be negative and the whole circuit unstable.

Next the condition that sufficient energy be supplied to make up for the ohmic losses gives

$$\delta i\,\delta v \geq r(\delta i)^2$$

and as $\delta i\,\delta v$ is positive,

$$r\frac{\delta i}{\delta v} \leq 1$$

$$-r\left(\frac{1}{R} + \frac{\delta A}{\delta v}\right) \leq 1$$

$\therefore$ to obtain best supply of energy to condenser circuit we require R very large and r very small.

Suppose $\frac{1}{R}$ may be neglected, compared with $\frac{\delta A}{\delta v}$, then condition becomes

$$-\frac{\delta v}{\delta A} \geq r$$

Thus it is possible if $\frac{\delta v}{\delta A}$ is negative and numerically greater than r, for the condenser circuit to receive sufficient energy during each very small complete oscillation to compensate for the energy dissipated in ohmic losses during the oscillation. For larger oscillations, similar but more complicated expressions will probably be required.

INSTITUTION OF ELECTRICAL ENGINEERS (DUBLIN SECTION).

ON ELECTRIC CURRENTS OF HIGH TENSION AND GREAT FREQUENCY.

Abstract of a Paper read by the Rt. Revd. Monseignor Molloy, D.D., D.Sc., December 20th, 1900.

Dr. Molloy said he had chosen this subject, partly because it was sufficiently novel and important to make it interesting on its own account, and partly because it suggested many questions, both scientific and practical, which were eminently suited for discussion by the I.E.E. The remarkable phenomena presented by electric currents of high tension and frequency were first brought to public notice in a series of brilliant experiments about 12 years ago by Nicola Tesla, of America. The lecturer did not pretend to rival the brilliancy of Tesla's experiments, but he hoped to show that even with the resources of a slenderly equipped laboratory, these experiments could be repeated on a scale of sufficient magnitude to enable his audience to understand the principles they involved and to discuss the problems they suggested.

He began by describing the apparatus employed to produce high frequency currents. It consisted of a 10-inch spark induction coil, which received a current from seven cells of a storage battery. The secondary of the induction coil was connected with a Leyden jar, which discharged itself automatically over a circuit in which was a spark-gap of about 1 cm. in length. The spark discharge obtained under these conditions was an oscillating phenomenon, *i.e.*, while the discharge itself lasted only for about $\frac{1}{100000}$th part of a second, or even less, it consisted during that time of a series of oscillations to and fro, like the swing of a pendulum, before it came to rest. These oscillations were next allowed to flow through a second induction coil, which for convenience he would call the Tesla transformer, where the E.M.F. was raised to something like 50,000 volts or more. The currents developed in the secondary coil of this transformer were the currents of high frequency with which they had to deal.

The first experiment he would show them was intended to illustrate the peculiar character of the spark discharge. In this experiment the Tesla transformer was not employed, but the circuit of the spark discharge consisted of a stout copper wire bent into the shape of the letter U. Across the arms of the U was stretched a thin copper wire, in which was interposed an ordinary electric glow-lamp. Now, they knew what would happen if a continuous current were sent through such a circuit as this. Two alternative paths are offered to the passage of the current: one round the loop of the U, which had hardly any resistance, and one across the bridge, including the glow-lamp, which though shorter than the first, had a very considerable resistance. The current would therefore divide itself between the two paths, according to a well-known law, inversely as the resistance, nearly the whole of it going round the stout copper wire, and only a very insignificant fraction passing across the bridge. The result would be that no sensible effect would be produced upon the lamp. But with periodic currents the case was altogether different. The obstruction offered to the passage of such currents (now commonly called *impedance*) depended not on the resistance only, but on the self-induction of the circuit, and when the frequency was very great, as in the case of a spark discharge, it depended almost entirely on the self-induction, and hardly at all on the resistance in the ordinary sense. In a circuit such as that before them, self-induction was practically proportional to the length of the circuit, and therefore the greater part of the discharge would leave the stout copper wire and pass across the bridge. The spark discharge was then produced, and the electric lamp glowed brilliantly, showing that the currents were passing in that part of the circuit, notwithstanding its great resistance.

There was an important lesson to be learned from this experiment. A flash of lightning consisted of oscillations of great frequency, just like the spark discharge. Consequently, when it got into an ordinary lightning conductor, the obstruction offered to its passage depended almost entirely on self-induction, and hardly at all on the resistance of the conductor. This was the reason why it sometimes happened that a large part of the flash left the stout copper rod and found its own way to earth through a series of imperfect conductors, doing much harm on the way. These views were first pressed on the attention of the public by Prof. Lodge, of Liverpool, now Principal of the University of Birmingham, at the meeting of the British Association at Bath, about 12 years ago, and though they met with some opposition at the time, they were now generally accepted. It was unnecessary to go beyond the experiment just made to see that they were true. Here a path of very little resistance was offered to the discharge of the Leyden jar, and yet a large part of the discharge broke away from that path and followed a line of imperfect conductors. It was interesting also to observe that just as the sideward splash of the discharge in the experiment, when it gets into the bad conductor, makes the carbon filament glow with heat, so the sideward splash of the lightning discharge, when it gets into the gaspipe of a public building, often melts the pipes and lights the gas.

The lecturer next proceeded to exhibit a series of experiments commonly known under the name of Tesla experiments. He showed that if one pole of the secondary coil in the Tesla transformer is connected to earth, and the apparatus put into action, the electric oscillations surging to and fro in the coil, overflowed at the other pole, and streamed away in the form of streaks of bluish light, like the brush discharge of a powerful electric machine.

He also showed that the space around the transformer is a field of electric force, in every part of which vacuum tubes and phosphorescent tubes were set aglow.

It was a remarkable fact, he said, that he could put his body in the path of these electric oscillations without feeling any inconvenience. To illustrate this, he took in his right hand a brass cylinder, connected by a flexible wire with one pole of the secondary coil in the Tesla transformer, while in his left hand he held a long vacuum tube. When the apparatus was set working, the tube at once began to glow, showing that his body served in some sense as a conductor of the high tension high frequency currents. Now, it was well known that alternating currents of 3,000 or 4,000 volts pressure, and a frequency of 100 complete periods in the second are usually fatal to life. How then was he able to bear with impunity these currents of at least 50,000 volts pressure and a frequency of 100,000 per second? The answer to this question, he thought, depended chiefly on two considerations.

First, currents of very high frequency have not time to penetrate into the substance of the conductor, but only glide over the surface. Hence they are less likely to act on the vital functions than currents of much less frequency. But this reason in itself was not enough.

The oscillations of a flash of lightning had a frequency comparable with that of a spark discharge, and yet a flash of lightning is often fatal to human life. We should remember then in the second place, that the electric charge in the case of the Tesla experiments was exceedingly small. It was like a rifle bullet, weighing, say, $\frac{1}{1000}$th of a grain, discharged by a powerful explosion of gunpowder. With a flash of lightning the case was widely different, because the electric charge was very much greater. The oscillations of a lightning flash, compared to the oscillations of the experiment, were as the size of a thunder cloud compared to the size of a Leyden jar (Should not "oscillations" be "charges"?) or as the roar of the thunder compared to the cracking of the electric spark.

He wished to call attention to the quality of the light produced in these experiments, because from one point of view at least, it was far more economical than any form of light at present in use. He then went on—The waste of energy that occurs in every existing kind of artificial illumination is simply enormous. According to the best determinations recently made, hardly 2 per cent. of the radiant energy of a gas flame consisted of luminous rays, that is, rays that act on the retina of the eye and awaken the sensation of vision; all the rest, *i.e.*, 98 per cent. of the whole, consists of dark heat rays, which are of no use for the purpose of illumination, and may, therefore, be called waste. In the electric glow lamp 5 per cent. of the radiation is luminous and 95 per cent. is wasted. The arc lamp is more economical, but even here only 10 per cent. of the radiation is luminous and 90 per cent. is wasted. The question then arises whether it may not be possible to devise some form of light in which a far larger proportion of the energy expended shall be effective in producing luminous rays and a much smaller proportion in producing dark heat rays which are of no avail for the purpose of illumination.

It is an interesting fact that we have in Nature a remarkable example of such a light, viz., the light of the glow-worm and the light of the firefly. Sir John Conroy has shown that the light of the glow-worm is comprised entirely within the limits of the visible spectrum. The radiation of the firefly was examined with extraordinary care and skill, about 10 years ago, by Prof. Langley and Mr. Veng at the Alleghany Observatory in America. The result of their investigation was to show that there are no dark heat rays associated with the light of the firefly, and that the luminous rays lie in the brightest part of the spectrum, *i.e.*, between the middle of the red and the borders of the blue. From this they concluded that the light of the firefly is the most economical form of light known, and they suggested that it ought to be within the possibilities of science to produce a light of the same quality, which would be immensely cheaper than any existing form of artificial light.

Now, the electric glow that we have seen in our experiments this evening seems in some measure to fulfil the anticipations of Prof. Langley. According to a careful investigation lately carried out by Prof. Staub, of the University of Zurich, the light of these vacuum tubes approximates closely to the light of the firefly It contains more than 96 per cent. of luminous rays, and somewhat less than 4 per cent. of dark heat rays. But however economical it may be, this light in its present condition is too feeble for practical use. The problem, then, which presents itself to us is to make the light more intense while preserving its character unchanged. With a view to the solution of this problem, I would venture to make one or two suggestions.

In the first place, I would remind you that in the high tension currents which we have used in our experiment, the charge of electricity is extremely small. No doubt we start with a current of some 4 or 5 units, but this current is afterwards passed through two induction coils. In each coil the E.M.F. is immensely increased, and as the quantity is diminished in the same proportion, it follows that the quantity present in the final currents which produce the electric glow must be only a very small fraction of a unit. Now it is quite conceivable that arrangements might be made under which the small quantity of electricity in the final currents would be greatly increased, and thus we should get a corresponding increase in the brightness of each successive flash.

Next let us turn our attention to these flashes and consider at what rate they follow each other in the tube, and how long each flash lasts. The flash occurs only at the moment of the spark discharge. I estimate that in the arrangement on the table we have about 10 discharges in the second, and each discharge lasts for about the $\frac{1}{100000}$th of a second. Thus you will see that the periods of brightness are very short compared to the intervals of darkness. You have first a flash which lasts for about the $\frac{1}{100000}$th of a second, and then you have a period of darkness which lasts for practically the $\frac{1}{10}$th of a second—*i.e.*, 10,000 times as long. What is needed, therefore, is to produce these flashes more rapidly, say 100 or 1,000 times in the second instead of 10 times in the second, and there seems no reason, from the scientific point of view, why this should not be possible.

We have now reached the stage at which this question passes from the scientific laboratory to the workshop of the electrical engineer. You have at hand the material for making experiments on a scale far surpassing what can be reached in the laboratory of the scientific man. Instead of beginning with a few cells of a battery and an induction coil, as I have done this evening, you would naturally set about your experiments with an alternating current machine and a step-up transformer. From the transformer you would charge a suitable condenser; the condenser would then give you spark discharges of large quantity in swift succession, and with these spark discharges you would illuminate your vacuum tubes with flashes of great brilliancy, following one another with great rapidity; or, perhaps, you would proceed on bolder lines, and dispensing altogether with condenser and with coils, you would build an alternating current machine that would give you at once oscillations of 100,000 volts pressure and 100,000 alternations per second, and you would apply these oscillations directly to the illumination of your tubes.

I will not deny that there are many difficulties to be encountered before these speculations can be realised in actual fact; but it is the business of practical men to encounter and to overcome practical difficulties. And I think I may say with confidence that if any of you should be fortunate enough to surmount these difficulties, and to produce a light of the same economical character as we have seen to-night, and of a brightness, let me say, 1,000 or even 100 times as great, he will not only make his name illustrious for ever in the annals of science, but in the famous words of Dr. Samuel Johnson, "he will acquire the potentiality of growing rich beyond the dreams of avarice."

Discussion.

Prof. M'Clelland said the study of the discharge through gases promised most success from a scientific point of view, and perhaps also from the practical. It seemed important to endeavour to act on *all* the gas in order to get increase in the light; at present only about 1 per 1,000 molecules is acted upon. It would almost seem necessary to reconsider the chemical notions as to the subdivision of matter.

After various speakers, Dr. Molloy, in reply, said: The Wehnelt interrupter had not been altogether reliable, though the fact that 100 volts could be used on the coil was an advantage. He hoped shortly to try a mercury jet interrupter (? FitzGerald's). As regards lightning, he thought that where damage was occasioned, lightning conductors should be compulsory; he instanced Pietermaritzburg, where there was formerly great damage from lightning storms; now, every house had its conductor, and there was practically no damage ever experienced.

A very hearty vote of thanks was accorded to Dr. Molloy for his able paper.

SYSTEMS OF CURRENT DISTRIBUTION ON TRAMWAYS.

(*Concluded from page* 891, *Vol.* 47.)

Traction by Accumulators.

Accumulator traction has had a good trial in Paris since 1892. In their paper before the Congress, Messrs. Broca and Johannet considered the subject from the point of view of construction, capacity and weight of cells, duration and maintenance of apparatus, and the economic applications to tramway traction. No progress has been made since 1898, when one Krüger described the Hanover system, which was mixed trolley and accumulators. The batteries were formed of 202 Tudor elements with Planté positives of 85 dcm.^{2} surface between two negatives carrying 300 grammes of active material. The capacity was 25 ampere-hours, and the discharge rate 25 amperes. The total weight was 2,000 to 2,500 kilos., according to the age of the plates. Special care was taken in their mounting as regards insulation and ventilation, and the prevention of harm from the acid. A battery would serve for 8,000 to 12,000 kilometres between each complete cleaning. After cleaning the capacity of the battery was measured, and it was placed for duty on such line as best suited its new capacity. Thus the plates were used to their last limit; then when fully worn out, new plates were added, and any old plates still having further life were used to replace plates in nearly worn out batteries, so as to enable the whole to run to the very last. The negatives are cleared of old paste, and repasted. The kilowatt-hour costs 6·25 centimes (·625d.) without depreciation charge, which is nearly equivalent to that of an overhead line.

The cost of keeping up, deduced from two years' experience, was 2·616 centimes per car kilometre, on a basis of 4,296,442 km. run by the batteries, and only 1·386 centimes on a basis of 8,168,888 km. on the basis of the total run of the cars, *i.e.*, including the trolley mileage duty also.

The authors consider that the system, not perhaps good in itself, may nevertheless do good service if well applied, and without being partisans of accumulator traction, they recommend accumulators where it is not practicable to employ the trolley wire, for the first cost is small, and a considerable fraction of this is returned in old lead. There is no change necessary in track. Then the load on the station or charging engine is regular. All vehicles are independent, while for a small traffic accumulators have a distinct superiority. They recognise that accumulator traction is not to be preferred, and state that to secure the best results the batteries must be suited to their duty; they must be charged at a central station. The plates must be made by the traction company itself. Batteries must be charged slowly; they must be well designed, and the vehicles and the depôts and terminus well arranged for examination of the batteries and for general attention and care.

Rapid charging is particularly bad for durability, causing speedy deterioration of the plates. It demands greater weight of battery and less utilisation of their capacity. Hence the battery should be capable of being removed quickly from the car and another battery put in. The car thus remains idle a minimum time, while the battery can be charged at leisure.

Car Heating.

While the heating of trains has made much progress, the warming of tramcars has not, by reason of the many difficulties. Thus

there is a door at each end of a car, and there is but little space in which to stand a stove. The two doors when both open at once cool down a car rapidly. Five systems are considered, namely:—(1) Portable apparatus such as water bottles and *chaufferettes;* (2) stoves; (3) hot air; (4) steam or hot water; (5) electricity. The International Assembly in 1894 came to the conclusion that it was undesirable to heat city cars, but suburban cars required heating, and this is held to be the case to-day.

The one advantage of stoves is their simplicity and economy. A stove only costs about 35 francs for a 24-place vehicle, and the fuel only 25 centimes for a day of 15 hours.

System 3 comprises a hearth inside or outside the vehicle heating air by radiation, this air being set free inside the car. The cost is 350 francs per car, and the daily expense 5 centimes per car-kilometre. It is difficult to regulate the temperature. In Utrecht about 320 litres of gas were used daily in a car 8 metres long, the outside temperature being 3° to 5° and that inside the car 16° to 18° C.

A hot water system costs 300 francs per car to instal, and uses 37 centimes' worth of fuel per day. Another cost 314 francs to instal and used 33 centimes per day of charcoal at 58 francs per tonne. A third system cost 200 to 250 francs to instal and 30 centimes per car day to work. For electrical warming the cost in Hanover has been 50 francs per car to instal, with an expenditure of energy for 10° C. of temperature difference of 1·75 KW.-hours per car hour, or, say, 2 francs per 16 hours day, a very high price, which confirms our own experience of the costliness of electric car heating.

THE AMERICAN LAW RELATING TO ELECTRICITY.

A RECENT article published by an esteemed American contemporary, entitled "New Legislation Affecting the Use and Misuse of Electricity," sets forth, in a manner which is at once clear and entertaining, certain important changes which have lately been made in the law relating to electricity in the United States. Seeing that our trans-Atlantic friends are running neck and neck with us in all matters electrical, it might be supposed that their "law of electricity" had been kept up to date. To judge, however, from the article referred to, the majority of the States in America have until recently been but poorly equipped with that legal machinery which is necessary to restrain misappropriation and improper use of the electric current.

It is pointed out that hitherto "the stealing" of electricity, as it is called in Connecticut, or the "malicious obstruction, disturbance, or division," as it is termed in other States within the Union, has been to a large extent unchecked. The wily operator has been at liberty to tap or steal telegraphic messages, and gain valuable information from the wire which runs along the street, but generally (to quote the words of our contemporary): "For the tapping of power or electric light lines the modern highwayman comes in out of the rain. He can do his business better indoors by attacking the electric meter, confusing its calculations, and thus getting more current than he pays for. Such at least seems to be the implication of recent statutes in America."

Stringent enactments, imposing heavy fines or terms of imprisonment, have now been passed in the more important States. A method of surreptitiously obtaining electric light was found to be practised in some instances by connecting wires to the lines of the company without authority, and thus tapping the current and using the current stolen for power purposes. With a view to prevent this, in two States Acts have been passed providing that any person who taps or connects with any electrical apparatus, or with any electric light wire for the purpose of obtaining an electric current for light, power, or heat, or for any other purpose whatever, without the knowledge and consent of the owner thereof, or the person or persons or corporation operating the apparatus, appliances, pipes, or wires, or who maliciously tampers with or injures any such apparatus, pipes or wires, is guilty of a misdemeanour punishable by fine or imprisonment.

Mere larceny of electricity is not, however, the only evil with which those in authority have had to deal. It appears that a practice has grown up in some places of giving electricity, or facilities for telegraphic communication, free of cost, to certain persons, such as city and village officials. This practice is condemned on the ground that it is neither more nor less than a form of bribery. In future the companies are forbidden to give free or reduced rates to any officials, and the officers or agents of a company bestowing their favours in this way are liable to a fine of £100 to £500, and to imprisonment. Electric light companies committing the same offence are liable to the same fine.

Such are a few of the recent developments of the law relating to electricity in the United States. If an English electrician has leisure to pursue his investigations further, he will find many things to interest and astonish him in this branch of American law. For instance, as our readers are probably aware, the transmission of telegrams in America is in the hands of private companies. The result is that they can be held liable in damages for any injury which arises from delay or error in the sending of a telegram. In this country the sender of a telegram is compelled to employ the Postmaster-General who, like his august Mistress, is sheltered under the ancient maxim that "The King can do no wrong." In the United States, however, it is far otherwise.

Many extraordinary cases where damages have been recovered from telegraph companies for delay or inaccuracy in the transmission of telegrams are solemnly noted in American legal text-books. Thus in Western Union Telegraph Company *v.* Procter, the plaintiff's daughter, aged 15, had eloped. The plaintiff, being desirous of preventing the marriage, telegraphed to the clerk of the county not to issue a license, as the daughter was under age. The telegram was delayed, and did not arrive at the clerk's office until after the couple were married. The Court held that the father could recover for damage to his feelings. Nor, apparently, is the right of action confined to the *sender* of the wire. In some States the addressee may also have his action. In a recent case in Alabama, where a message was sent: "How is Ma? Answer at once," the message being sent by a brother to his sister, and another brother sent an answer, which was negligently delayed by the telegraph company, it was held that the person sending the first message, requesting an answer, made the person sending the reply his agent, and consequently might maintain an action of contract on the telegram and recover nominal damages for the breach, and in addition, damages for mental suffering.

Seeing that Americans have recently discovered that their statute books (for their name is legion) provided insufficient means of protecting electric supply companies against the evil doer, it is interesting to consider how far our own companies are protected in this country by the Electric Lighting Acts. It is a singular fact that all the evils to which we have referred in the earlier part of this article were foreseen by those who framed the Electric Lighting Act of 1882. By a crafty incorporation of certain sections of the Gasworks Act, consumers or other persons are prohibited from tampering with any meter or preventing it from duly registering the quantity of electricity supplied, and this enactment is apparently wide enough to cover every possible method by which a meter can be made to "lie." For instance, we have heard of an ingenious individual who suspended an immensely powerful electro-magnet in the neighbourhood of his meter. This had the effect of preventing the mechanism from rotating while the current from the mains was used *ad. lib.* for the purpose of working the electro-magnet and lighting the consumer's house. To a charge of larceny he made the following specious reply, "I may suspend an electro-magnet where I like in my own house!" Under the above section he would clearly be liable for "tampering."

Another section of the Electric Lighting Act brings electricity within the list of "articles" which can be the subject-matter of larceny at common law, while Sec. 20 of the same statute, which provides that no undue preference shall be shown to any local authority, company, or person, effectually prevents that form of bribery with which our friends across the water appear to be troubled.

Referring to the question of electrocution, our contemporary states that "In civilised communities, if the death penalty persists, the electric current will no doubt displace the rope and the ax" (*sic.*, for they drop the "e" in America). We venture to hope that this method of executing criminals will never be introduced in our own land. Granted that when properly applied in sufficient strength the electric current is capable of causing instantaneous death, the disastrous consequences which attended its first use in

America make one recoil with horror at the suggestion that a fresh series of experiments should be commenced in this country.

THE USE OF SEARCHLIGHTS IN NAVAL WARFARE.

Recent manœuvres in the Mediterranean have shown searchlights to be a very effective means of defence when properly used, but the position from which they are used requires very careful consideration.

As regards the direct use of the light in revealing an approaching enemy, there is much to be said on both sides. In the case of a fleet steaming in company on a dark night, and attacked by torpedo boats, the only means of defence is obviously to turn all searchlights on, and endeavour to repel the attack by a sharp gun fire, unless there is any chance of eluding them under cover of the darkness.

Experiment has proved that in the case of a night attack by torpedo craft, the advantage lies very much on the side of the small craft, who can easily make out the dark silhouette of the upperworks of their huge adversaries, while they themselves are practically invisible. By turning on the searchlights, therefore, the chances are more equalised, for although the act reveals to the attacking boats the position of each ship, it at the same time gives a target for the guns.

Now the results of night firing at a target lit up by the searchlight are deplorably weak, and when this target happens to be a torpedo boat going at full speed, one is forced to admit that the chances of destroying her before she can discharge her torpedo are not great; still there is no alternative, and I think it is generally considered to be a bad case for the fleet attacked, for it must be remembered that, although several boats may be put out of action, if only *one* can get her torpedo in, the attack is successful. No one who has not tried to pick up a torpedo boat with a searchlight, or having picked her up, to keep the light on her, can have any idea what a difficult matter it is.

Of course, torpedo nets add very considerably to the strength of the defence, but they are not infallible.

The circumstance under which a torpedo attack is most to be feared, however, is that in which a ship, temporarily disabled, is lying at anchor in port, awaiting repairs. I propose to give a brief sketch of the conditions under which experiments in this direction have been tried and the means of defence adopted.

A suitable port for the purpose having been chosen, the ship was anchored, her nets got out and placed, and all possible preparations made for the reception of an attacking flotilla, which had orders to deliver an attack on a certain night. The boats were totally unaware of what preparations would be made or what would be the position of the ship in the harbour.

The defence was prepared as follows:—Searchlights were placed one on either side of the narrow entrance and guns were landed to form a small battery on either side, the searchlights were trained upon a buoy placed in the centre of the channel, so that any boats entering the harbour were bound to pass through one or other of the two beams. All lights were extinguished in the ship, and patrol boats were sent out to give warning, by means of coloured lights, of any approach, the colour and nature of the light indicating the direction from which the attack was coming; another searchlight was placed in a boat moored off to the right front of the ship, throwing a diverging beam which would, by throwing a dazzling light in the eyes of the attacking party, screen the ship from view.

The night was ideal, heavy rain squalls and thick clouds combined to make the darkness intense, and beyond the two beams at the entrance of the harbour there was nothing to give the slightest clue to the attacking force.

About three hours after darkness had set in, a light from one of the patrol boats indicated an attack from the North, and soon after, a boat was seen to pass at full speed through the beam to the right of the harbour mouth, closely followed by a second. The screening light moored off the ship was now turned on, and a heavy fire directed at the first boat as she advanced, the light at the entrance endeavouring to pick up the second. At this instant two more boats passed through the beam to the left, one of which was picked up by the light in the upper top of the attacked ship, this light being turned on and the flash of the guns revealed her position at once to the attacking party, but not before the first boat, completely dazzled by the screening light, had run upon the rocks and put herself out of action. The remaining four boats fired their torpedoes, one of which missed altogether, while the other three went into the nets, two so close together that the first would have cleared a way for the second in reality by its explosion, but it was claimed that one of their boats had been under fire long enough to disqualify her in the opinion of the umpires, and so the attack was judged to have been in this instance unsuccessful according to the rules.

However, the fact still remained that in spite of the various searchlights, two boats had entered and discharged their torpedoes almost unobserved; it is a fact that is difficult to realise when we remember that they actually had to pass through the beam at the entrance before they could get in at all.

A comparison of the experiences of both parties shows the enormous importance of the position of searchlights. Those on the water line completely destroyed the vision of the occupants of the boats while in the ray, though being of little value to the gunners, who could not distinguish any definite target through the intense white light, whereas the highly-placed light from the fighting top, although making a better target for the gunners to direct their fire, also gave a good indication to the torpedo boats of the ship's position, so that, firing their torpedoes at a spot immediately below it, they were able to make pretty certain of getting their torpedoes home, while to those on whom the rays were not shining, the upper light and the flash of the guns were an excellent guide to enable them to determine how the ship lay, and direct their attack accordingly.

Coloured glass shades were used by those in the boats with advantage. By their means the dazzling effect of the higher projectors could be very much reduced, but it was a different matter with the low ones, which cast an impenetrable glare that can only be compared to a dense fog, through which nothing was visible but the position of the projector itself and the flashes of the guns. When these flashes proceed from a shore battery, and the projector is removed from the ship, the effect is entirely misleading, and the boat taking the gunfire to be proceeding from the ship is led to discharge her torpedo at the shore or else, in attempting to get closer, dashes herself upon the rocks, as was the case with one of the boats in this instance; but, on the other hand, the gunners found it almost impossible to distinguish any object when attempting to fire from above the beam, though the boats showed up clearly enough when they were firing underneath it, as was the case with the light from the upper top.

The problem resolves itself into the question of whether it is worth while using the top light for the benefit of the gunners and thereby revealing the ship's position more clearly to the boats, or whether it is better to trust entirely to the screening effect of the low light, in which case the ship's guns must remain silent and trust to the shore battery to do the work, bearing in mind that the shore battery is still under the very great disadvantage of firing through the screening light. It is, perhaps, difficult for those who have not experienced the conditions, to realise the effect of viewing an object through the beam of a searchlight.

A boat steaming through the light is only seen by the reflection upon her mast funnels, &c., and she therefore shows up as a white object against a somewhat paler background, the contrast is only made by the increased light in the beam due to reflection from the boat.

When the observer is so near to the projector that his line of vision enters the beam some distance ahead of the advancing boat, his eye receives the reflection of dust particles in a more concentrated part of the beam, and the light from them is proportionately greater, reducing the contrast very considerably, so that the boat becomes almost invisible. Hence we see that the searchlight itself should be as far removed from the gunners as possible before good gun practice can be expected.

ONE METHOD OF DEALING WITH THE HIGH VOLTAGE ARC LAMP TROUBLE.

By J. G. GRIFFIN, Chief Assistant, Burnley Electricity Works.

THERE are very few station engineers working with a supply pressure of 200 volts or over who will not heartily endorse the expression "trouble" in connection with high voltage arcs, and it is hoped that this article may direct the attention of at least one of these gentlemen to a measure for relief which has been tried and has succeeded.

The Electric Light Department of the Burnley Corporation are favoured with an unusually large percentage of arc lamp consumers, and when the Committee—acting on the advice of Mr. W. R. Wright, their late engineer—decided to raise the voltage from 105 to 220 at consumers' terminals, it was, of course, realised that all these lamps would have to be taken over by the department, and new enclosed lamps erected in their stead.

Between 40 and 50 of those to be taken over were open type lamps owned by consumers, a few were single enclosed lamps owned by consumers, and there were between 70 and 80 other single enclosed lamps on hire from, and belonging to, the Corporation. A rather large order certainly, but in view of the great benefits to be derived from "changing over," by no means a deterrent, and arrangements were therefore made with lamp makers of highest repute in the kingdom for supplying the necessary new lamps.

As luck (?) would have it, when the fateful "change-over" day arrived, the only new lamps which had come to hand were those for burning singly on 220-volt circuits, and these were slung up as speedily as possible by the station staff in place of the old 105-volt enclosed lamps—no consumers protesting (for they *knew* not!)

It is unnecessary to describe the astonishment or the wrath of these consumers when their new lamps had been working for a week, but it will suffice to say that in a very short time the remainder of the arc lamps on order were stopped.

It was not expected that consumers would be altogether enthusiastic at getting a blue light for a white one, but the storm that ensued was simply amazing; the members of the Committee stated that life was one veritable burden of complaints to them, and the lot of the engineer can be only imagined.

The principal faults of the 220-volt arcs, in comparison with the low-voltage lamps, were as follows:—The carbons lasted less than half the time, far more heat was given off, the light was not nearly as steady, and lastly, but chiefly, the arc gave scarcely one-fifth of the light, and that fifth of such a quality that it was utterly impossible for any shop-keeper to distinguish the different shades of his coloured materials.

For a few months this state of affairs had to be borne, and during that time very many other types of lamps were tested at the station, but were all found equally disappointing. The engineers of other large towns, which had raised their pressure, were asked to give the name of a satisfactory lamp, but everyone of them replied with the same tale of woe; indeed, several letters were received asking how Burnley proposed to get over the difficulty, and after about 50 of the lamps we had on circuit had burned out for various reasons, the Committee decided, on the urgent recommendation of Mr. Birkett (Mr. Wright's successor), to adopt the following scheme:—In the accompanying diagram (fig. 1) A represents our main generator, and B B_1 two machines forming the three-wire balancer. It was proposed to obtain two small three-wire balancers, C C_1 and D D_1, connect one of them across each side of our three-wire system as shown, and from the middle wires of these small balancers to run cables, E and F, through the afflicted (or arc lamp) area, and to tap off from one of these cables to each arc lamp consumer, according to whether the latter was on the positive or negative side of the system. The consumer's arc lamp leads would then be connected (by the department) between the new service wire and one of the mains already on the premises, and the old 105-volt lamps (with a little extra resistance) would be put up once more.

Tenders for plant and mains were asked for in May, 1900, and three months later we commenced to lay the cable. Owing to the facts that the cables run were only to be used as balancing wires, that all services could be put on at once, and that the little idiosyncrasies of each arc lamp user were

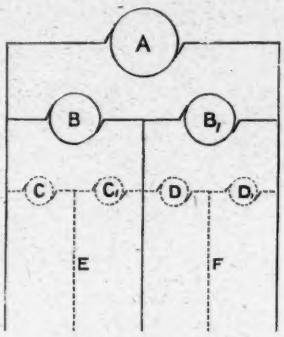


FIG. 1.

well known to us, it was possible to so balance one service against another, that the section of the cable needed was very small indeed, and since the system was started the out-of-balance current has very seldom been as high as 45 amperes on either balancer. It ought, perhaps, to be stated that consumers taking over 25 amperes had their lamps arranged on each side of the arc lamp service wire.

Two ·08-inch cables with a twin pilot were run from the station to a distributing box about 450 yards distant, from thence branch circuits of ·035-inch cable, diminishing to ·022 inch, were run for a total shop frontage of about 1,000 yards. Callender's solid system was adopted, and the service connections, of course, were put in as the cable was laid, a S.P. switch with fuse box, and a 110-volt meter being fixed at the same time in consumers' cellars. The cables all being laid, and the balancers bedded down and connected up, we started to connect the consumers' arc lamp leads across the 110-volt circuits. This work, of course, necessitated some little inconvenience to the shop-keepers, but they were all far too keen to get back to the low voltage to grumble—even at the extra meter rent.

The first balancer was run with three consumers on the new circuit on October 4th, and the rest of the consumers on that side of the system were finished off within the next two weeks. The remainder of the work was completed early in November, the whole scheme, with the exception of the actual laying of the cable in its troughing, being carried out by the staff of the department. The balancers are each made up of two similar machines coupled together, and by cross-connecting the fields of these, they are nearly self-regulating, and run with very little attention.

It was stated above that a "twin" pilot wire was run to the distributing box, and as it will probably not be clear how

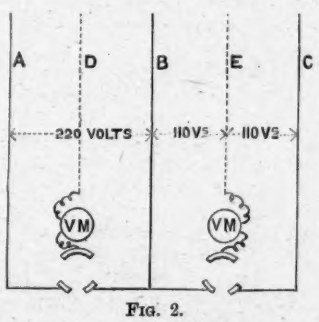


FIG. 2.

a five-wire system can be controlled by two pilot wires, it may be mentioned that our principal three-wire pilots are taken from a point within a few yards of this distributing box, and these latter pilots are made to serve for both purposes. Further, only two new voltmeters are required for regulating the four new circuits, as will be seen from fig. 2, for since we know that there is 220 volts between

the pilot wires A and B, then if the V.M. shows 110 volts between D and B there is *bound* to be 110 volts between D and A—a simple two-way switch however, is provided.

Ordinarily, the balancers will only be run five afternoons and evenings per week, but in case a consumer wishes to use his lamps on an early closing day, or during the 16 hours a day when the balancers are not working, he is made to ring a bell at the works by the novel (?) arrangement shown in fig. 3. Two 32-C.P. lamps are connected in series across one

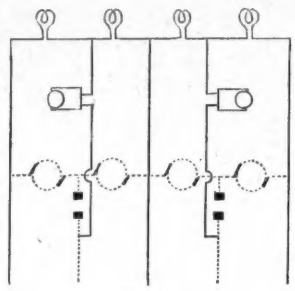


FIG. 3.

of the outers and the middle wire of the three-wire system, and the centre wire from these lamps is connected through a bell to the arc lamp balancing wire on that side of the system. It will be seen at once that when an arc is switched on, one of the incandescent lamps will be short-circuited, and current will pass through the bell, causing it to ring, and making the other incandescent glow brightly. The switch-board attendant starts up the balancer concerned immediately the bell commences ringing. A little experimenting had to be done before this arrangement was got satisfactory, but it now works perfectly.

Looking at the scheme from the business point of view, the total cost has worked out at just under £1,200 (the engineer's estimate). A loan for this amount was applied for and granted by the Local Government Board, and it may also be of interest to state that the Board of Trade intimated that the scheme was covered by our original provisional order.

Had the work only been done before raising the supply pressure, the net cost would have been £1,200 *less* the cost of obtaining some 130 new arc lamps.

The firm conviction of Burnley's borough electrical engineer is shown by the adoption of this scheme, and if a mere assistant may so far presume, the writer would strongly commend this system to those engineers who are now meditating a change to the higher pressure. It would not pay, of course, if the arcs were distributed over a wide area, but most continuous stations, at any rate, have the bulk of their arc lamps in the three or four principal streets.

To put down a "five-wire system" merely for making arc lamps burn in a better manner does sound a trifle "heroic," but taking our own case, for instance, the three alternatives open to us were as follows:—

1. Lose many of our largest consumers and have endless trouble with the remainder who used arcs.
2. Persuade consumers to burn series lamps.
3. Fix resistances on consumers' premises to dissipate an amount of energy equal to that taken by the lamp.

The only remark necessary to make in regard to the first alternative is, that a large number of our best consumers were already making overtures to the Gas Department—and the trouble with the others having 220-volt arcs was getting worse and worse. In reference to the second—if any reader has a particular turn for persuasive eloquence, the writer can recommend him no better exercise for his talent than to *try* to persuade a hard-headed business man of Lancashire to burn and pay for two arc lamps where he only wants one.

As to the third alternative, assuming that places could be found for the resistances on consumers' premises—only half the energy then taken could have been put down on consumers' bills. Now the department earns a revenue of about £700 a year from arc lighting, and if even half the users had agreed to burn series lamps to oblige us, it would still have meant that an amount of energy equal to that for which we now obtain £350 per annum, would have had to be supplied for all time, without one penny piece coming back for it.

Nothing original is claimed for this system,* except the putting it into practice, but it is claimed that it is a working success, it is simple and easy to control, efficient in its working, and from its inception has given the greatest satisfaction.

In conclusion, the writer has to express sincere thanks to his chief, Mr. Robt. Birkett, for permission to communicate the above. It is, of course, under that gentleman's supervision that he (the writer) has seen to the carrying out of this little scheme.

CURRENT SPECIFICATIONS.

XLIII.—FARNWORTH ELECTRIC TRAMCARS.

SUMMARY.

Extent of Contract.—Supply of eight completely-equipped electric tramcars; double-deck, capable of seating 66 passengers; for 4 feet 8½ inches line gauge; maximum traction pattern truck.
Character of Car Body.—To comply with the drawing issued with the specification.
Size of Motors.—Two with each car, to be capable of propelling the car together with a load of 3½ tons, at a speed of 9 miles per hour on a gradient of 1 in 16, and to be capable of starting the car on this gradient. Each motor to be capable of giving not less than 30 H.P. at the wheel tread.
Permissible Temperature Rise.—The temperature rise of any part of the motor shall not exceed 70° F. above atmosphere after four hours' run with a load equivalent to 10 H.P. at a speed equivalent to 100 revolutions per minute of the car wheel.
Type of Rheostat.—To be of one of the following patterns:—B.T.H. Co., British Westinghouse Company, or Dick, Kerr & Co. Alternative types may be considered after the contract is placed. To be of the series parallel type, fitted with electric rheostatic brake.
Trolley Pole.—Swivelling type, having springs adjusted to give an upward pressure against the trolley wire of 15 to 20 lbs.
Lightning Arrester.—To be of approved type, and so arranged that it shall not be thrown out of action after many discharges.
Spares to be Included.—As per list given in specification.
Date of Completion.—Nine months from date of order.
Penalty for Late Completion.—£10 per car per week.
Specified Terms of Payment.—See comments below.
Stipulations as to Removal of Foreman.—None.
Stipulations as to Wages paid to Workmen.—See comments below.
Arbitration Proposals.—Limited, see comments.
Date for Receipt of Tenders.—January 10th, 1901.

This specification has been prepared by the consulting electrical engineers to the Urban District Council, Messrs. Lacey, Clirehugh & Sillar. It may be taken as a fair average specification of a modern British electric tramcar. It will be noticed that the standard of comfort demanded in the car is far higher than was the case a few years ago when horse-propelled cars were the rule. In this, British practice is only following American experience, where the finish of the cars has considerably improved since the adoption of electricity as the propelling agent.

The cars asked for are of the bogie double-deck type, each to seat 66 passengers, 30 inside and 36 outside. Maximum traction trucks are demanded, together with both mechanical and rheostatic brakes. A number of guarantees as to the efficiency and performance of the motors under varying conditions are to be given in the tender.

We do not think it is fair to specify three makes of controllers, and then state that alternative types will only be considered after the order is placed. It would, in our opinion, be preferable to permit firms to offer any type of controller, and leave it to them to convince the engineers that it would satisfactorily fulfil the conditions of the specification.

The general conditions in many respects are similar to those issued with the Swindon specification, which were

* Mr. Wordingham suggested the idea at the M.E.A. conference in 1896.

criticised in our issue for December 14th. The differences are, to a large extent, due to the absence of work to be done on site in the present contract.

The attention of tenderers is called to Clause 7, which states :—

The contractors shall satisfy themselves as to the dimensions, character, and nature of all existing works, and other things so far as they may have any connection with the works of the contract, and shall obtain their own information on all matters which can in any way influence their tender.

It will also be necessary for due provision to be made for the cost of the tests which the engineers may demand to be made before delivery, as follows :—

The contractors shall provide, without extra charge, all such labour, apparatus, instruments, and appliances as the engineers may consider requisite to test the plant, material, or work, and shall at all times make all necessary arrangements for the assistance of the engineers or their representatives to accomplish such tests.

Before the works are taken over by the Council *the contractors shall, at their expense, test the operation thereof in the presence of the engineers and in the manner provided by the specification.* The contractor shall provide all superintendence, labour, materials, apparatus, instruments, and appliances necessary for the test.

Satisfactory provision is made for an extension of the time for completion :—

If the completion of the works, or any part thereof, shall have been delayed by combination of workmen, strikes, or lock-outs, or by any other unforeseen circumstances (other than lack of money) which the engineers may consider to have been beyond the control of the contractors.

Under terms of payment 10 per cent. of the contract sum will be withheld for a period of 12 months, and as the clause relating to payments during the period of manufacture is not at all clear, it will be well for contractors to carefully peruse them before fixing their price. The clause reads :—

No money shall be considered due until the engineers have given their certificate of completion, but for the convenience of the contractors *instalments on account shall be paid on the written certificate of the engineers to the extent of 50 per cent. of the value of the cars on delivery.* When the cars shall have been completed and tested to the satisfaction of the engineers, they shall give the contractors the certificate of completion thereof; and the Corporation shall take over the cars, and the engineers shall take into account all advances and payments made to the contractors, and all damages, penalties, and expenses paid or incurred by the Council and under this contract to be borne and defrayed by the contractors, and shall certify the balance payable to or by the contractors ; and *any such balance shall be paid to the contractors forthwith except as to 10 per cent. of the total amount of the contract price, which shall be paid 12 calendar months* after the taking over of the cars by the Council and on the certificate of the engineers that the cars are to their satisfaction, and that the contractors have duly performed all their obligations under this contract. No certificate given by the engineers shall be regarded as an admission of the due performance of this contract.

This may mean that monthly payments will be made, calculated on the value of the cars on delivery, or it may be interpreted as deferring all payments till delivery is made on site.

Our remarks of the 14th ult. as to the limited nature of the arbitration clause are applicable in the present instance.

The only other clause needing comment is that relating to wages to be paid to workmen. It reads :—

The contractors undertake that in carrying out the contract *all workpeople employed on or in connection with the work shall be paid the regular standard rate of wages as recognised by the various Trades Unions and Employers' Associations* shall be observed. Should the contractors commit a breach of any of the conditions of this clause, they shall not be asked to tender again for Council work unless and until the Council otherwise decide. *Any question arising as to what are the standard rate of wages and the hours and conditions of labour to be settled between the Trades Unions and the Masters' Associations concerned.*

Standard wages are to be paid under pain of not being allowed to tender for future work to the Council, and representatives of the Men's and Masters' Associations are to be the final court of appeal for disputes on this matter. In this stipulation we see reflected the custom in Lancashire cotton mills to leave to trained experts, representing both masters and men, all questions relating to wages. Whether the plan will work as satisfactorily in engineering factories, we have not enough experience at present to decide.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1900.

Compiled expressly for this Journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

23,005. "A trolley pulley adjuster for electric tramcars." D. L. REANEY. Dated December 17th.

23,014. "Improved high voltage quick-break single-pole double-poles or multi-poles switch." A. E. SHORT. Dated December 17th.

23,087. "Improvements in apparatus for electrically operating keyed musical instruments." S. K. REYNOLDS. Dated December 18th. (Complete.)

23,103. "Improvements in electric railway systems." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. B. Potter, United States.) Dated December 18th. (Complete.)

23,104. "Improvements in systems of motor control." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (A. H. Armstrong, United States.) Dated December 18th. (Complete.)

23,105. "Improvements in galvanic batteries." C. A. ALLISON. (The Waterbury Battery Company, United States.) Dated December 18th. (Complete.)

23,107. "Improvements in galvanic batteries." C. A. ALLISON. (The Waterbury Battery Company, United States.) Dated December 18th. (Complete.)

23,113. "Improvements in current motors." C. JASPER. Dated December 18th. (Complete.)

23,137. "Improvements relating to plugs for electric switches." M. VOGEL. Dated December 18th.

23,146. "Improvements in electricity meters." E. SCHATTNER. Dated December 18th.

23,155. "Improvements in the arrangement and connection for single and multiplex wireless telegraphy." V. I. FEENY. (Allgemeine Elektricitäts Gesellschaft, Germany.) Dated December 18th. (Complete.)

23,163. "Improvements in portable apparatus for wireless telegraphy for military and other purposes." J. A. FLEMING and MARCONI'S WIRELESS TELEGRAPH COMPANY, LIMITED. Dated December 18th.

23,168. "Improvements in and connected with electric circuit closing apparatus." P. CARUS. Dated December 18th.

23,234. "An electrical apparatus for operating signal and other levers." R. ALIOTH, E. BERNHEIM, and E. SARTIAUX. Dated December 19th.

23,240. "Improvements in motor gear-cases for electric cars." W. COX, J. M. SMITH, and A. M. SMITH. Dated December 19th.

23,246. "Improvements in and relating to electric motors and generators." M. KALLMANN. Dated December 19th.

23,308. "An improved process and apparatus for the manufacture of lead castings for electric batteries and the like." THE BRITISH TRACTION AND LIGHTING COMPANY, LIMITED, and G. J. GIBBS. Dated December 20th.

23,309. "Improvements in electrical accumulators." THE BRITISH TRACTION AND LIGHTING COMPANY, LIMITED, and G. J. GIBBS. Dated December 19th.

23,310. "Improvements in electrical accumulators." THE BRITISH TRACTION AND LIGHTING COMPANY, LIMITED, and G. J. GIBBS. Dated December 20th.

23,314. "Improvements in electrolytic apparatus for production of chlorine and alkali." J. MACTEAR. Dated December 20th.

23,323. "Improvements relating to speed regulators for electric lifts." J. WETTER. (The Elektrizitäts-Aktiengesellschaft vormals Schuckert & Co., Germany.) Dated December 20th. (Complete.)

23,323. "An improved controller and switch for motors for electric lifts." J. BUSH. Dated December 20th.

23,329. "Adjustable connections for electric lamps." T. H. BRIGG. Dated December 20th.

23,359. "Improvements in insulators for electric conductors." S. J. ATKINSON and W. SCHMAHL. (G. H. R. Büttner.) Dated December 21st.

23,366. "Improvements in or connected with electric motors." W. WHITELEY, jun. Dated December 21st.

23,385. "An improved machine for winding electric cables on drums or reels." E. A. CLAREMONT. Dated December 21st.

23,386. "An improved electric dry core telegraph and telephone cable." E. A. CLAREMONT. Dated December 21st. (Complete.)

23,389 "Improvements in regulation of dynamo-electric machines." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (A. D. Lunt.) Dated December 21st. (Complete.)

23,390. "Improvements in controller casings." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (C. L. Perry.) Dated December 21st. (Complete.)

23,391. "Improvements in electrically-operated switches for controlling circuits at remote points from central stations." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (H. R. Sargent.) Dated December 21st. (Complete.)

23,392. "Improvements in means for preventing fluctuations in rotary motors." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (A. L. Hadley.) Dated December 21st. (Complete.)

23,393. "Improvements in means for preventing fluctuations in rotary motors." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (J. J. Wood.) Dated December 21st. (Complete.)

23,394. "Improvement in electric brake system." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (F. E. Case.) Dated December 21st. (Complete.)

23,395. "Improvements in means for transmitting motion to a distant point." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (D. P. Thomson.) Dated December 21st. (Complete.)

23,396. "Improvements in rotary transforming apparatus." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. W. Rice, jun.) Dated December 21st. (Complete.)

23,397. "Improvements in systems of electrical distribution." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (C. P. Steinmetz.) Dated December 21st. (Complete.)

23,398. "Improvements in systems of electrical distribution." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (C. P. Steinmetz.) Dated December 21st. (Complete.)

23,408. "Improvements relating to electric accumulators." A. POUTEAUX and A. WOLFF. Dated December 21st.

23,417. "Improvements in or relating to galvanometers." A. BLONDEL. Dated December 21st. (Date applied for under Patents, &c., Act 1883, Sec. 103, June 6th, 1900, being date of application in Belgium.) (Complete.)

23,422. "Improvements in or connected with controllers for use with electrically-driven capstans and analogous purposes." W. H. SCOTT. Dated December 21st.

23,432. "Improvements in electric bells." W. R. LAMBERT and VERITYS, LIMITED. Dated December 21st.

23,433. "An improved cut-off for electric arc lamps and similar electrical installations." W. R. RIDINGS and VERITYS, LIMITED. Dated December 21st.

23,434. "A new or improved water-tight holder for electric lamp globes." P. G. EBBUTT, C. P. BROWN, H. S. SMITH, and VERITYS, LIMITED. Dated December 21st.

23,448. "Improvements in telephone switchboard cords." A. WHALLEY. Dated December 22nd.

23,461. "New method of impregnation and isolation of endless protecting pipes, tubes, or cylinders, to lay underground cables, electric wire, and other conductors or liquid acid, &c." WAYSS and FREYTAG. Dated December 22nd.

23,462. "Moulding machine for manufacture of protecting channels for the purpose of laying and protecting underground conductors, cables, electric wires, or liquid acid, made of cement, concrete, beton, or any other artificial stone or material." WAYSS and FREYTAG. Dated December 22nd.

23,484. "Improvements in the means of controlling electric motors." E. H. TYLER and C. A. CARUS-WILSON. Dated December 22nd.

23,485. "Improvements in electric motor control." E. H. TYLER and C. A. CARUS-WILSON. Dated December 22nd.

23,487. "Electro-mechanical emergency brake for tramcars driven by electricity." E. VON PLANTA. (Date applied for under Patents, &c., Act, 1883, Sec. 103, June 23rd, 1900, being date of application in Switzerland.) Dated December 22nd. (Complete.)

23,490. "Improvements in or relating to electric switches." F. H. HEADLEY. Dated December 22nd. (Complete.)

23,491. "Improvements in means for extinguishing arcs formed on the breakage of electric circuits." T. H. MINSHALL. Dated December 22nd.

23,492. "Improvements in and relating to methods for testing electric circuits." T. H. MINSHALL. Dated December 22nd.

23,514. "Improvements in electric house service and fuse boxes." W. T. BURLEY and A. J. CLARKE. Dated December 22nd. (Complete.)

23,523. "Improvements in electric block signalling, and in supplying electric current to trains in connection therewith." B. CRUVELLIER. Dated December 22nd. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

1,765. "A surface-contact electric traction system." S. P. Thompson and M. Walker. Dated January 25th, 1899. Relates to electric railways and tramways with surface contacts connected alternately to high and low pressure conductors. The vehicle is provided with two or more skates running on the same row of studs, and the leading one takes current through them from the high potential main, while the follower returns current to the low potential main. The switches, which are operated by electro-magnetic or other suitable means, may normally keep the studs connected to the low pressure mains, or may rest in a mid position. The studs may be arranged in two sets of odd and even numbers, and the return current passes through a coil which throws the switch to couple the stud next but one ahead to the high potential main. Or a shunt from the main current through a coil throws the switch and the coil is cut out by a subsidiary switch operated by a magnet on the vehicle before the low potential skate comes on the stud. In a modification, the shunt coil is short circuited by a subsidiary skate and stud connected to the return through a resistance. 5 claims.

1,834. "Improvements in rail bonds for electric traction systems." H. Hirst and J. O. Zealander. Dated January 26th, 1899. Rail bonds adapted to lie under the fish-plates consist of two plates with hollow plugs and pins on their ends fitting together and into holes in the rail. Each plate may have one or more plugs or pins at either end, and the plugs or pins may be split. 2 claims.

1,841. "Improvements in and relating to collectors or trolleys for electric tramways and the like." R. N. Tweedy. Dated January 26th, 1899. Relates to collectors for electric railways and tramways with overhead conductors. Compressed air is used in the place of the usual springs to hold up the trolley pole, &c. The tail end of the pivoted pole socket is connected to a piston working in the cylinder carried on a bracket on the swivelling base. Air under pressure is supplied through the central tube and swivelling union and is controlled by a three-way cock or otherwise. 3 claims.

1,844. "Improvements in the manufacture of plates for secondary batteries." L. Champagne. Dated January 26th, 1899. The plates or grids for holding the active material are made with cells or recesses, the internal diameter of which is larger than that of the sides. The plate is formed by casting molten metal in the mould, which comprises a metal plate upon which is fixed by screws a copper plate provided with symmetrically-arranged holes. Above this is fixed a cast metal rectangular frame, in one side of which is a groove for the escape of air. In each of the holes is fitted a core piece of chalk or other material of the shape required to form the cells and the mould is then closed by an asbestos pad and a cast metal plate which is recessed to form a gate for the inflowing material. The core pieces are subsequently removed from the cast plate by dilute hydrochloric acid. 3 claims.

1,862. "Improvements relating to the transmission of electric telegraph signals without connecting wires." F. Braun. Dated January 26th, 1899. Relates to systems of wireless telegraphy in which waves of low frequency are employed, such as are generated by a Leyden jar. One or more Leyden jars or equivalent condensers may be employed at the transmitting station, with either one coating as shown, connected to the vertical rod, or the discharge may take place in the primary circuit of an induction coil, one terminal of the secondary being connected to the vertical rod. The ordinary receiving apparatus is employed. 2 claims.

1,863. "Wireless electric transmission of signals over surfaces." F. Braun. Dated January 26th, 1899. Relates to the arrangement of the earth connection for wireless signalling. Any arrangement for producing the oscillations, such as an induction coil, influence machine, or condensers with or without induction coils, may be employed, the two terminals being connected to earth plates. At the receiving station, the coherer is similarly connected to earth, the centre point being connected to an earthed local circuit 1 claim.

1,865. Method of, and apparatus for controlling the operating gears of rudders, signals and the like by means of heat, light, or electrical waves." A. Orling and C. G. G. Braunerjelm. Dated January 26th, 1899. (Date claimed under Act, October 26th, 1898.) Relates to apparatus for controlling the steering-gear of torpedoes or other vessels, and signals and other electrically-operated apparatus, by means of heat, or electric waves. In the arrangement described, the resistance of a receiver is decreased when subjected to heat, light, or electric waves. It is in circuit with an electro-magnet which controls the switch of a relay circuit including a magnet. This magnet operates a switch to close the circuits alternately. The magnets are thus excited to actuate, directly or indirectly, the rudder or other apparatus. The movable portion of the switch is made so that each excitation of the magnet reverses the current in the main circuit. 7 claims.

1,866. "An improved receiver for waves of light, heat, or electricity." A. Orling and C. G. G. Braunerjelm. Dated January 26th, 1899. (Date claimed under Act, October 27th, 1898.) Relates to receivers of the coherer type for waves or radiations of light, heat, or electricity, more especially for use in ships, railway trains, balloons, &c., for signalling the presence of other vessels, or objects, &c., in the vicinity. The receiver consists of a series of spherical or cylindrical conducting bodies, of a suitable material sensitive to the radiations, mounted between terminals, in an insulting trough, which is enclosed in an exhausted casing. For ships, the casing is mounted on a universal joint or gimbal, but for other uses it may be directly journalled in the stand. The terminals are connected in circuit with the battery and the electro-magnet of the relay. The resistance between the bodies is normally so great that the relay is not operated, but when subjected to the action of the electric or other radiations from the transmitting station, the resistance of the receiver is regulated by pointing the casing towards the transmitting station, and adjusting the inclination of the casing. A scale which is fixed to the casing and works past the fixed pointer is provided to facilitate adjustment. The scale may be formed with a series of holes, to engage a locking-pin adapted to fix the apparatus in the position to which it is adjusted. By providing the lighthouses, vessels, or other transmitting stations with transmitters emitting radiations of a certain strength, and by suitably graduating the scale, the distance from the nearest vessel, &c., can be ascertained. For light radiations the bodies may be made of selenium, &c. 4 claims.

1,867. "Improvements in apparatus for regulating the sensitivity of receivers for waves of light, heat or electricity." A. Orling and C. G. G. Braunerjelm. Dated January 26th, 1899 (Date claimed under Act, October 27th, 1899.) Relates to receivers of the coherer type for waves or radiations of light, heat or electricity in their application for directing torpedoes or other vessels. Two rows of sensitive conducting bodies are employed, the former resting between the terminals on the bottom of the insulating holder, and balls being arranged above and between the balls. The holder is enclosed in an exhausted casing. The terminals are connected through the battery and the electro-magnet of the relay. The terminal is adapted to slide without rotation in the bearing and the screw threaded to receive the armature, which is rotated by the electro-magnet, driven by suitable gearing from a shaft or other moving part of the machinery, such as the shaft of the screw propeller. By these means, as the torpedo or vessel moves away from the source of the controlling radiations, the rotation of the armature retracts the terminal and allows the bodies to fall deeper between the bodies, so increasing the sensitivity of the receiver. For light radiations the bodies may be made of selenium, while for electric control the bodies are preferably diamagnetic and the bodies paramagnetic. 3 claims.

1,868. "A device for regulating the distance between objects hermetically enclosed applicable to receivers for waves of heat, light or electricity." A. Orling and C. G. G. Braunerjelm. Dated January 26th, 1899. (Date claimed under Act, October 27th, 1899.) Relates to means for regulating the distance between hermetically-enclosed objects, and is applicable to receivers of the coherer type for waves or radiations of heat, light, or electricity. The objects are sensitive to the radiations employed, and are enclosed in the tube fixed in the airtight casing. The casing is revolubly mounted in the fork which is mounted on a horizontal pivot on the standard and fixed by the wing nut. The spindle of the movable terminal is screw threaded to receive the nut, and slides in the bearing. A weight is attached to the nut and carries a pin, &c., adapted to enter one or other of the notches in the flange of the disc, which is fixed to the tube. To regulate the distance between the objects, and consequently the sensitivity of the apparatus, the fork is tilted on its pivot, until the pin is disengaged from its notch and then the casing is rotated, the nut being prevented from rotating by the weight. When adjustment is affected, the fork is returned to the normal position and clamped, the weight being again locked by the pin engaging in one of the notches. In a modification, the weight is attached to the spindle and the nut is omitted, the spindle screwing through the disc. 5 claims.

1,869. "Improved electrical condenser and apparatus for producing powerful electric waves." A. Orling and C. G. G. Braunerjelm. Dated January 26th, 1899. (Date claimed under Act, November 20th, 1898.) The nobs of radiators are formed hollow and filled with small conducting bodies, such as shot, enveloped in a non-conducting material, such as paraffin. The conductors from a machine such as the Holtz machine are introduced into the knobs, but are insulated from them. The knobs thus form condensers. The two knobs are immersed in insulating material in a suitable closed vessel, and one or both are carried by sliding plates so that the distance apart can be adjusted. 3 claims.

1,921. "Improvements in electric arc lamps for stage and the like purposes." J. Webster. Dated January 27th, 1899. Relates to arc lamps, regulated by hand, for stage and like purposes. The carbons are held in screw clamps bolted to angular levers which are pivoted at their ends in a fork movable horizontally by a screw; this is carried by a block which is clamped by a screw on a vertical rod fixed on a base-plate. The levers are also pivoted at their angles to blocks which slide on the vertical rod and are pressed away from the intermediate block by springs. The upper lever carries a reflector which is slotted to pass the lower lever. Stops on the screw limit the movements of the levers. The base-plate slides between guides in a box, and may be fixed by a screw; the box has grooves for a lens and coloured glasses. 4 claims.

1,941. "Improvements in electric incandescence lamp pendants or brackets." H. Hirst and J. Murphy. Dated January 27th, 1899. An arm may be turned horizontally about a pivot and carries a slider which is slit to form tongues gripping the arm. The slider carries pulleys from which an incandescent lamp and a counterweight are hung by a flexible conductor attached to the pivot. The pulley may be replaced by means for securing the conductor to the slider, with sufficient slack to permit movement of the slider to the end of the arm. 2 claims.

1,960. "Improvements in electric railways of the sectional conductor type." J. G. Lorrain (T. C. Esmond.) Dated January 27th, 1899. To cut-out the sectional conductors passed by the vehicle, three arrangements of the switches with double armatures are described. The circuit between the main conductor and the sectional conductors is completed when the armatures are attracted to make the contacts. In case the lower armature sticks and only the upper armature returns to the off position, a path is opened to earth through the contact so that the main current blows the fuse. The main circuit is broken by the lower armature only; the upper armature in connected to earth, and its contacts are connected respectively to the contacts and to the contact in the next switch, so that the main current may be earthed through a fuse and both armatures are normally earthed when out of action. The third form combines these arrangements with those described in Specification No. 21, A.D. 1899, for inter-connecting the switches, and reference is made to Specifications No. 7,694, A.D. 1896, and No. 21,249, A.D. 1897, for explanation of the methods of winding the switch magnets, but other arrangements may be used. 6 claims.

2,017. "An improvement in electric igniters for gas or oil motors." P. A. Decan. Dated January 28th, 1899. Electric igniting plugs are composed of a porcelain core, to which is attached by cement and screws a metal case, and which is then baked. The case bears a thread for screwing the plug into the combustion chamber and a bent wire terminal, while a conductor passes through the centre of the core and terminates in an approximately hemispherical cap. 2 claims.

2,074. "An improved electric arc lamp." C. E. Electrician. Dated January 30th, 1899. A clutch lamp, with enclosed arc, has a frame consisting of plates connected by two pairs of rods, and two curved rods between the plates. The globe is carried between a holder clamped on the plate, and a ring bolted to a plate. The lower carbon is passed up into the holder, a cap being removed, and is secured by a screw. The upper carbon is secured by a screw in an insulated guide, sliding on the rods, and connected by a flexible conductor. The upper carbon passes through a hole in a clutch hinged at one end to a rod, which is screwed into a flange on the core of a series solenoid. The clutch rests at the other end on the plate. The upper part of the hole in the clutch is cylindrical, the lower part being conical. The upward movement of the clutch is limited by contact of the rod with the solenoid; the solenoid also forms a dash-pot for the core. The plate may carry a reflector. 3 claims.